POWER

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Engineers Study the Engineer

"And all our knowledge is ourselves to know."

IN an effort to help its members, the American Society of Mechanical Engineers, through a committee of which its newly nominated president is chairman, is trying to learn something about the place of the mechanical engineer in the economic and social structure of America.

More and more the engineer is becoming sensible of the less-material phases of his profession and of its rôle in modern civilization.

He finds himself charged with consideration of the intangible as well as of the material factors of design and procedure; with the determination of the widsom and financial justification as well as of the mechanical soundness and sufficiency of suggested ventures; of the ultimate economy as well as of the mechanical efficiency of proposed constructions and processes; of management and of the effective use of manpower as well as of the grosser materials and force of nature for the benefit of man.

In true engineering fashion the committee is proceeding to establish the facts as a preliminary step in its consideration of the matter.

What process can be suggested or developed that will be of help to young men in determining their choice of engineering as a profession? Of all the incipient capability presented, how can that be sorted out which will best repay culture and training along engineering lines?

What has been or may be the most successful method of preparation for an engineering career? What should the schools furnish? What can the industries that need them and the cultures that will profit by them suggest or contribute as the best method or means of training the talent that they require? What are the best means for bringing capability, fitness, preparedness, eager for application, into contact with opportunity?

It is said that engineers do not receive social and professional recognition and emolument commensurate with the importance of the service they render. What are the facts? How do the earnings of the engineer compare with those of members of the other professions? What is the general estimate of the importance of the engineer, and the relative frequency of his choice for positions of honor and preferment?

When this information is collected it will be formulated into a report that will show the basic facts about mechanical engineers today. How soon this will be available will depend upon the promptness and thoroughness with which the members reply to the appeal for contributions from their personal experience now in their hands.

F. R. Low

EDITORIALS

Taking the Guess Out of Engineering

RESEARCH grew out of man's attempt to satisfy his curiosity concerning nature. Now, however, it is more frequently undertaken to satisfy the needs of the engineer—to provide, through scientific methods and systematic search, information required in the design of products, equipment and plants.

The function of the engineer is to combine known facts with "scientific" guesses based on experience. As the results of more and more research become available and the known facts increase, the work of the engineer becomes less a matter of guess and judgment.

Research has taken much of the guess out of power-plant design. Accurate steam tables and heat-transfer data have made it possible to predict performance closely. The work of the metallurgist has paved the work for high pressures and temperatures. But there is still and probably will always be a vast amount of research to be done before all of the guess can be eliminated from power engineering.

Cut Cost With Records

CUT POWER COSTS with cost records—with records that recognize the frailty of human intellect and conscience.

It is not enough to know that the total power cost for the month is so many dollars, of which so much is fixed charges, so much fuel, etc. Such a system, for all its attractive simplicity, conceals innumerable opportunities to save. True, it may hint that something is wrong, but it never tells where. And often its figures may be merely the signal to start a wild-goose chase.

Many possible causes may stand behind an increase in the total expense of power services. Coal may be up in price, or boiler efficiency may be down, or the demand for process steam may have grown, with or without good reason. Turbine-generator efficiency may have fallen off because of excessively warm circulating water. Using departments may be wasting refrigeration or trying to offset wintry blasts through open windows with excess steam in radiators.

To get very far in spotting and correcting wastes of generation and consumption, two things are clearly necessary. One is a breakdown of costs by services. Individual unit costs should be determined for electricity, high- and low-pressure steam, refrigeration, compressed air and other services. The other is a system of charging these services to consuming departments *on the basis of quantities actually used*, as determined by meter readings.

Such cost records, allocated according to fact rather than by guesswork, have many practical uses. A rising unit cost of steam, electricity or refrigeration will immediately center attention on the boiler room, turbine room or refrigerating plant, respectively.

If the total cost of all power services goes up without increase in unit costs, the answer must obviously be sought at the consuming end. Moreover, the record shows in which department the trouble lies and brings a direct charge against that department.

Under such circumstances decisive action automatically replaces the usual procedure wherein everybody agrees "to be careful" and goes right on with the good old-fashioned waste.

As the most direct route to lower power and manufacturing costs and to enhanced personal reputation, every plant engineer should utilize such records to the practical limit.

Mistaken Sales Policy Threatens Gas Vendors

AS BUSINESS persists in getting better with an aggravating deliberateness and at a rate which vies with the fabled tortoise, there is increasing evidence of a consistent deflation policy in many directions.

Competing companies appear to be bent upon the reduction of inventories and such other steps as will place them in the most favored position to sell their products under the new order as it now exists. Competitive groups are drawing up their lines of offense and defense. Weaker institutions are being absorbed by the stronger and aggressive steps are in process to so clean house that companies will not only be ready to go, but

so set up that they can live at least not unprofitably even with conditions as they are at present.

But in the enthusiasm of the moment let not the desire for business be so keen as to blind otherwise clear heads to the danger of building fences with material taken from a neighbor's. At best, the advantage of such practices can only be temporary.

As an example, some natural-gas companies are suggesting to industrial users that a main supply meter is the only one permanently necessary for measuring gas consumption and that individual meters to the different process branches, if needed at all, may be borrowed from them temporarily and then taken out.

If industrial consumers of natural gas were induced by this method to discontinue the principle of continuous check and control of gas consumption in each branch of their processing, it is possible that for a number of reasons gas bills would build up without restraint.

Any sales policy of vending companies which would knowingly permit increased gas use for no constructive purpose is like the house built without a foundation—upon the sand.—"And the ruin of that house was great."

Hand-Scraped Bearings

ON ANOTHER PAGE is a discussion on the present, almost universal, practice of scraping engine-shaft bearings. It is hardly probable that all readers will subscribe to the theory advanced—that hand scraping is unnecessary. Nevertheless modern machine methods should be accurate enough to give the necessary bearing surface.

It should not be assumed that limitation of bearing pressures determines the amount of the bearing surface that must be in contact with the journal. In fact, after the journal reaches a definite rate of rotation it leaves contact with the bearing and rides upon an oil film. The pressure exerted by this film may be ten time that based upon projected area. Consequently, even a contact of twenty per cent of the lower surface will create unit pressures much under the maximum oil-film pressure.

It is the preservation of the oil film that necessitates a fair bearing surface. When the machine is at rest for a time, the oil film disappears and there is metal-to-metal contact of the line, rather than area, type. When the machine is started, this metal-to-metal contact exists until the rate of rotation reaches some value at which an oil film is established, and the creation of this film is deterred by roughness of the surface of either the journal or bearing at the line of contact. If the bearing lining is finished sufficiently to permit rapid formation of this film, a greater refinement of finish is unnecessary. Slow-speed machines, or machines that operate over a range upward from low speed, require a better bearing than do high-speed machines. This reasoning indicates that the modern high-speed engine might be deprived of the expensive hand finish.

Forethought and Insulating Varnish

NOTWITHSTANDING all that has been done to improve electric-machinery insulation and construction, windings are still the chief source of outage. According to an analysis of breakdowns in electric machines made by the Vulcan Boiler & General Insurance Company, England, sixty-one per cent of the failures in direct-current motors were in the armatures and commutators and these represented over seventy per cent of the total cost for repairs.

On direct-current generators these percentages were over seventy-eight and eighty-four, respectively. Alternating-current motors showed similar percentages. In wound-rotor motors, stator and rotor windings accounted for sixty-five per cent of all failures and for over eighty-five per cent of the total repair costs. Stator windings alone in squirrel-cage motors were responsible for about the same total per cent of failures and repair costs as the stator and rotor windings of slip-ring motors.

If motor repair costs are to be reduced and reliability of the equipment increased, it is evident from the foregoing figures that the windings should receive particular attention. While the windings are subjected to many influences that tend to destroy their insulation, oil is one of the worst offenders. An investigation by the Association of Iron & Steel Electrical Engineers indicated that ninety per cent of winding failures in some plants were the result of oil on the insulation. These findings show that by keeping the oil in the bearings where it belongs up to ninety per cent of armature and field-coil failures can be avoided.

Windings in modern machines are thoroughly impregnated with an insulating compound that when new is impervious to moisture, dust and fumes. But the insulation does not remain that way. High temperatures dry it out, and minute cracks form, into which moisture and other injurious substances enter.

By periodically cleaning and drying windings and giving them a coat of insulating varnish, their insulation can be kept sealed against most of the elements that might give trouble. The cost is only a small percentage of that for rewinding a machine. A little forethought and insulating varnish will work wonders in reducing winding failures and expensive repair bills.

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POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

Each of the three pulverizers per boiler discharges into a turbulent type burner

At the Gatineau pulp and paper mill of the Canadian International Paper Company four 13,400-sq.ft. pulverized-coal-fired boilers are installed to supply the mill's steam, previously produced by three 42,000-kw. and one 21,000-kw. electric steam generators

Coal-Fired Boilers Supplement Electric Steam Generators

ONE OF THE largest newsprint mills of the International Paper Company and its subsidiaries is the Gatineau, Quebec, plant of the Canadian International Paper Company, near Ottawa, Ontario. In this plant process steam had been generated with electric power obtained from its associated hydro developments, but expansion made is necessary to supplement the hydro power with coal-fired boilers.

The new boiler plant has been built adjacent to the electric steam generator room and contains four pulverized-coal-fired units. The plant is built for maximum economical efficiency and is complete with coal-handling and storage facilities. In addition to high plant efficiency the outstanding features are compactness and simplicity of design. The plant contains the four largest steam-generating units in the Dominion, but the boiler room is of only moderate height and has no basement.

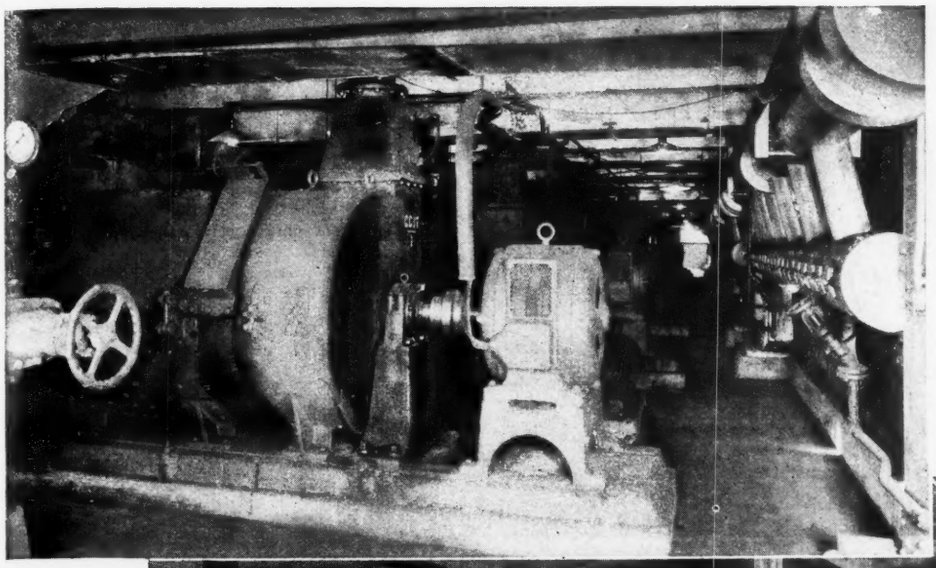
Over-all dimensions of the boiler room are 53.5 ft. high 61 ft. wide and 193 ft. long, including space left for the installation of a fifth boiler. Low height is obtained by a simple arrangement for removing ashes which eliminates the necessity of an ash basement and thereby reduced the building cost. Notwithstanding this compactness, every piece of equipment is readily accessible for inspection and repairs.

A cross-section through the center of one boiler unit is shown on page 730. Each unit includes a pulverized-fuel system, a 13,400-sq.ft. boiler, a water-cooled furnace, a convection superheater and a tubular-type air heater. The four units are served by a common flue connected through induced-draft fans to a single radial-brick stack, but each unit has its own forced-draft fan.

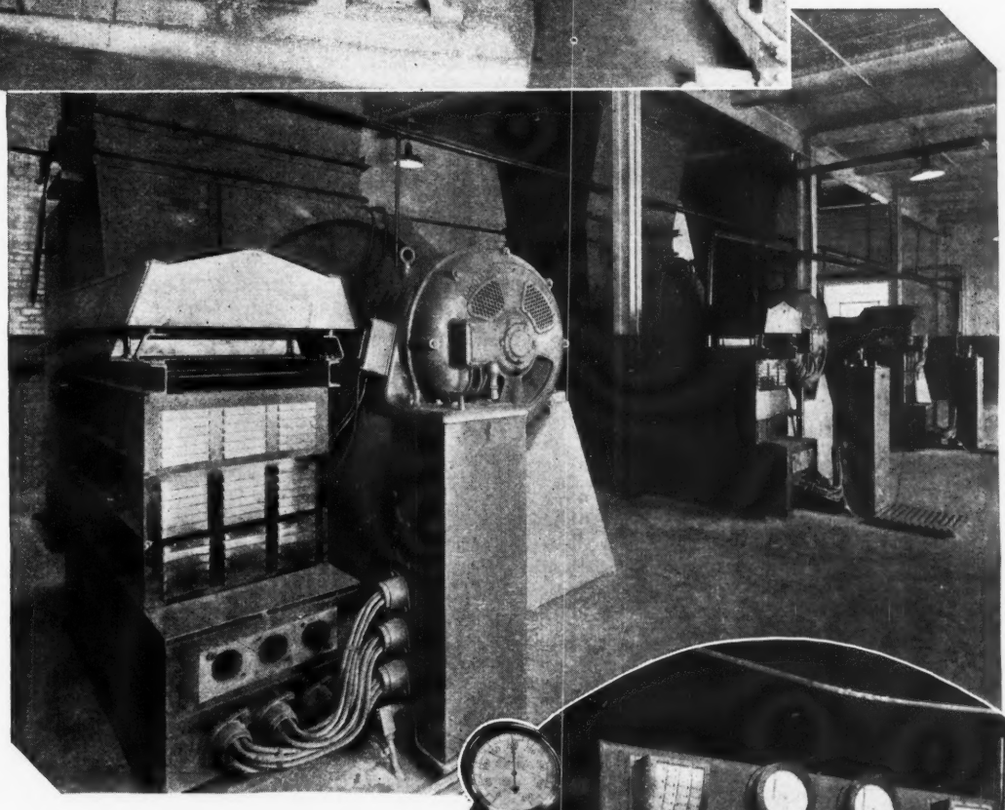
Coal is received by rail, the cars being dumped into a hopper which is emptied by a skip hoist, either into a chute to a drag-line storage system or into a ring crusher. The crushed coal is delivered by a belt conveyor to an overhead bunker in the boiler room. The coal on the belt is weighed automatically, so that a permanent record is kept of the total fuel burned. The bunker in the boiler room is of the plants-leg type, which is self-trimming and contains no dead storage or excess weight. A further advantage of this type of bunker is that the windows, placed between the lower portion of the bunkers, are effective for admitting light and for ventilation.

The overhead bunkers feed the three pulverizers of each boiler. These pulverizers are on the ground level below the operating floor. Two of the pulverizers for each unit have a capacity of 7,000 lb. of coal per hour and the third has a capacity of 3,500 lb. per hour. These capacities are based on the usually high percentage of moisture contained in Dominion coal when stored outside during winter months. Each pulverizer is driven by a direct-connected motor. Two different sizes of mills are used to give maximum flexibility. The small pulverizer of each boiler is capable of carrying the week-end load.

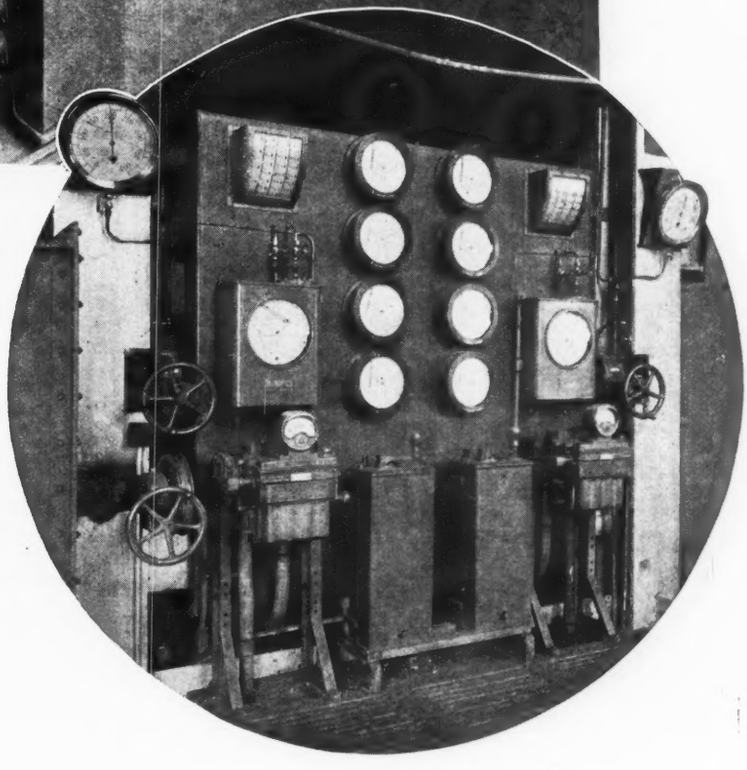
Each pulverizer discharges into a single turbulent-type



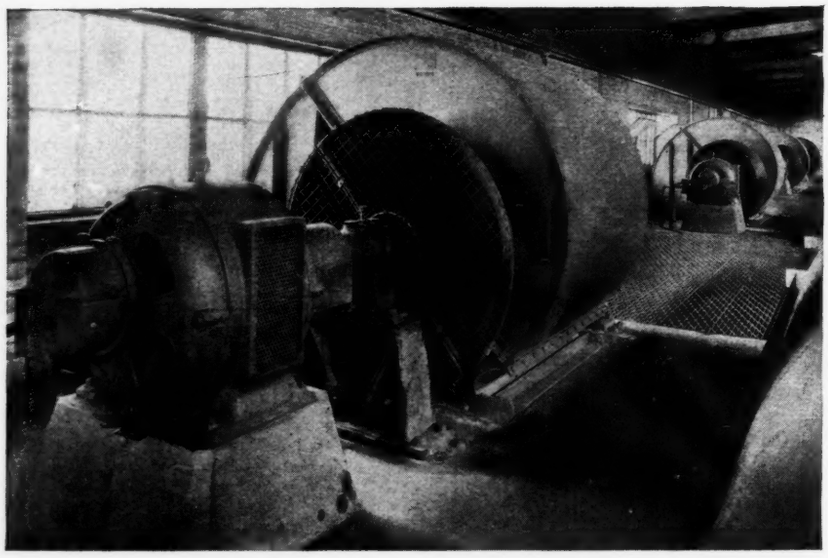
The coal pulverizers are on the ground level below the operating floor. Two of the three pulverizers on each boiler have 7,000-lb., and one 3,500-lb., capacity per hour



Above—Gases from the air heaters go to a common flue on the ground level, and three induced-draft fans above this flue discharge them to the stack



Right—All control apparatus and instruments are mounted on panelboards between each pair of boilers. From this position it is also possible for the operator to observe the boiler's water level and the flow of coal from the bunkers to the pulverizers

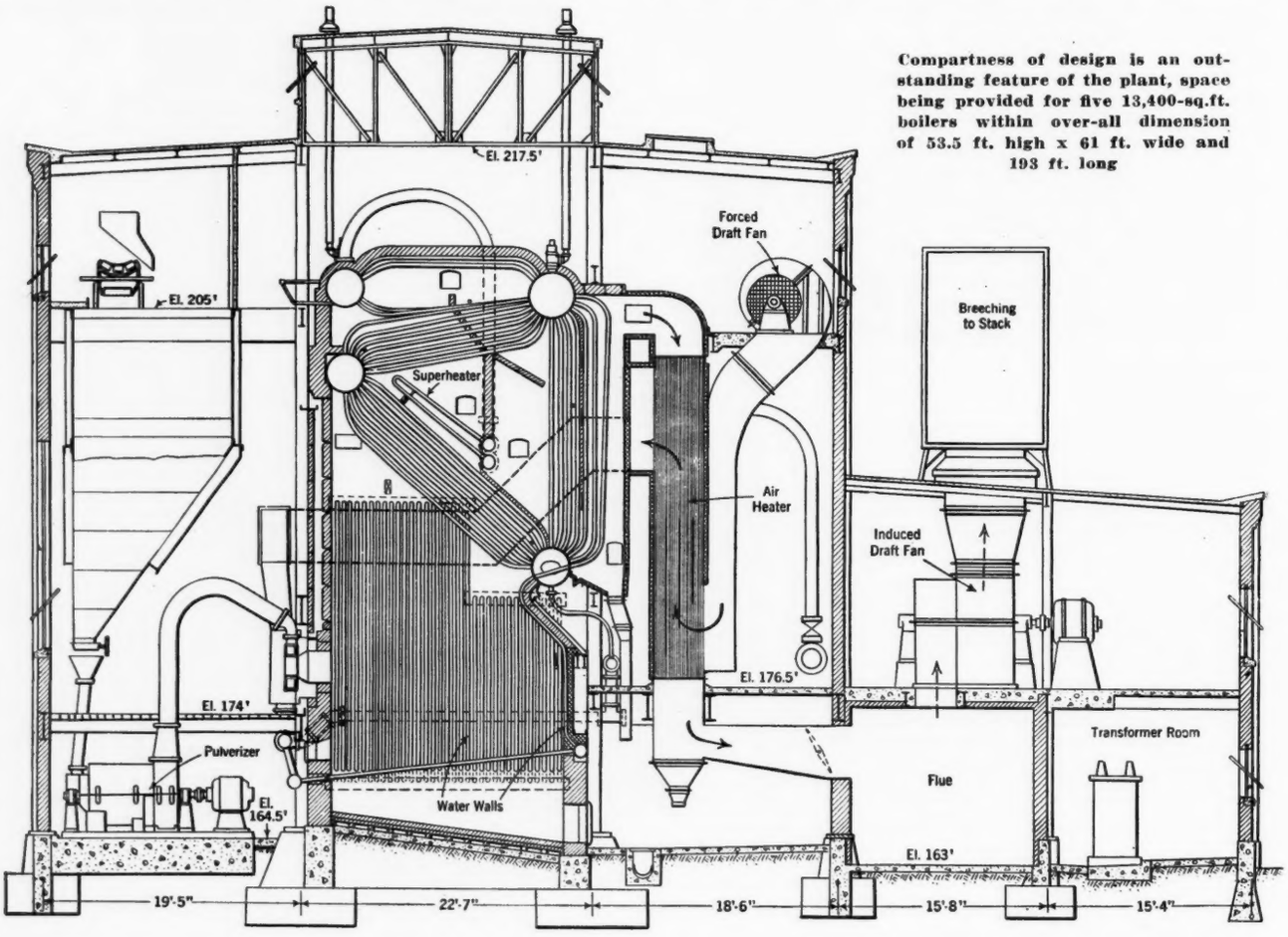


The forced-draft fan for each boiler is on the upper floor about 25 ft. above the air-heater inlet, permitting duct connections to be made to the heaters without abrupt changes of section

forced-draft burner. On each unit the three burners are adjustable for a high degree of turbulence and are placed in the front wall of the furnace at the operating floor level.

The furnaces are water-cooled on three sides and have air-cooled refractory front walls. A furnace volume of 6,600 cu.ft. is provided, which at normal maximum rating gives a heat liberation of 22,600 B.t.u. per cubic foot per hour. Side and rear walls of each unit are of wing-back construction, consisting of cast-iron blocks bolted to the tubes.

A water screen, which prevents slagging of ash, is about 5 ft. above the furnace floor. Below the water screen the furnace volume is about 1,800 cu.ft., which allows several days' accumulation of ash before removal is necessary. The furnace floor is of firebrick and is air-cooled. Ash removal is by means of a water stream from a hose with a long pipe nozzle introduced through doors at the rear of the furnace. The ash is washed out through these doors into a hydraulic sluice. To facilitate the washing process, the furnace floor slopes to the rear and has ridges of firebrick $4\frac{1}{2}$ in. high from front to rear dividing the floor into four channels, each leading to one of the four ash doors. The sluice runs the length of the



Compartness of design is an outstanding feature of the plant, space being provided for five 13,400-sq.ft. boilers within over-all dimension of 53.5 ft. high x 61 ft. wide and 193 ft. long

Principal Equipment in the Gatineau Boiler Plant of the Canadian International Paper Company

General

Plant location, Gatineau, Quebec.
Kind of plant, pulp and paper mill.
Capacity, 600 tons of newsprint per day.
New boiler plant designed by the engineering department of the Canadian International Paper Company.
Building construction and installation of equipment not installed by manufacturers was done by the company's own organization.

Boilers, Superheaters, Air Heaters and Water Walls

Manufacturer of boilers .....Canadian Vickers, Ltd.
Type .....Kidwell, bent-tube
Number 4
Working pressure, lb. per sq.in.....200
Steam temperature, deg. F.....450
Heating surface, sq.ft. 13,400
Normal steaming rate, lb. per hr.....117,000
Maximum steaming rate, lb. per hr.....136,000
Number of passes 3
Number of tubes, 878 — 3½-in., arranged 40 tubes wide.
Manufacturer of superheaters.....Foster Wheeler, Ltd.
Type, convection, bare-tube.
Superheat, deg. F.....60
Air heaters .....Foster Wheeler, Ltd.
Number 4
Type, tubular, 17,800 sq.ft. of heating surface.
Number of tubes, 1,134 — 2½-in., arranged 42 wide, 27 deep.
Water walls .....Foster Wheeler, Ltd.
Construction, wing back; side walls, 33 elements, 427 sq.ft. of wall coverage on each side; rear walls 40 elements, 280 sq.ft. of wall coverage.
Furnace volume above water screen, cu.ft.....6,600
Heat liberation at normal maximum rating, B.t.u. per cu.ft. per hr. 22,600
Water screens.....Foster Wheeler, Ltd.
Surface, 189 sq.ft. 20 — 3¼-in. tubes.
Furnace volume below water screen, cu.ft.....1,800
Front wall, air-cooled refractory.....M. H. Detrick Co.
Setting, exclusive of water- and air-cooled walls, 13½ in. of first-quality firebrick, 9 in. of second-quality firebrick, Atwood, Ltd.
Feedwater regulators, type S-C.....Swartwout Co.
Soot blowers, 12 per boiler.....Vulcan Soot Cleaner Co.
Blowoff valves .....Yarnall-Waring Co.
Safety valves, 5 — 4½ in. per boiler, Consolidated Ashcroft-Hancock Co.
Non-return valves .....Edwards Valve & Mfg. Co.
Heat insulation .....Atlas Asbestos Co.
Continuous blowdown system...Henszey Deconcentrator Co.

Pulverized-Coal Equipment

Manufacturer .....Foster Wheeler, Ltd.
Pulverizers, type, Aero impact.
Number per boiler, 3, two 7,000 lb. per hr. and one 3,500 lb. per hr.
Drive, 150-hp. and 75-hp. 1,150-r.p.m. variable-speed Crompton, Parkinson slip-ring motors.
Burners, one per pulverizer; turbulent, forced-draft type.

Draft Equipment

Forced-draft fans.....B. F. Sturtevant Co. of Canada, Ltd.
Number per boiler, one, double-inlet type.
Capacity, each 50,000 cu.ft. per min. at 8 in. static pressure.
Drive, 100-hp., 1,150-r.p.m., variable-speed, slip-ring type, Crompton, Parkinson motors.
Induced-draft fans.....B. F. Sturtevant Co. of Canada, Ltd.
Number, 3, single-inlet type, with bolted wheel construction and renewable cast-iron liners in casing.
Capacity, 135,000 cu.ft. per min., at 5½ in. static pressure.
Drive, 250-hp., 600-r.p.m., variable-speed, Crompton, Parkinson slip-ring type motors.
Ducts and breechings, steel-plate construction, Foster Wheeler, Ltd.
Chimney, radial brick, 15 ft. inside diameter, 200 ft. high, H. R. Reinicke, Inc.

Coal- and Ash-Handling Equipment

Coal bunker .....Canadian-Vickers, Ltd.
Type, ⅜-in. steel-plate.
Capacity, tons per boiler 175
Belt conveyor, 24-in. belt.....Link-Belt, Ltd.
Skip hoist .....R. H. Beaumont Co.
Type, double-bucket balanced.
Capacity, tons per hour 140
Drag scraper .....R. H. Beaumont Co.
Bucket capacity, 5,000 lb.; movable back-post car.
Coal crusher .....American Pulverizer Co.
Type .....Ring
Capacity, tons per hr.....140
Car puller .....Silent Hoist, Winch & Crane Co.
Weightometer .....Merrick Scale Co.
Ash-handling equipment.....Allen-Sherman-Hoff Co.
Type .....Hydrojet
Pump .....Canadian Ingersoll Rand Co., Ltd.
Capacity, 1,200 g.p.m. against a 240-ft. head.
Derrick, steel, stiff-leg with double-drum electric hoist and 1-cu.yd. clamshell bucket....Canadian-Mead-Morrison Co.

Piping and Valves

Pipe fabricated by.....Crane, Ltd.
Erected by.....Domill Construction Co. of Canada, Ltd.
High-pressure valves .....Walworth Co.
Low-pressure valves .....Jenkins Bros., Ltd.
Steel fittings .....Walworth Co.

Boiler-Feed Pump

Manufacturer .....Canadian Ingersoll Rand Co., Ltd.
Size 6-in. 3-stage
Drive, direct, steam turbine.....Terry Steam Turbine Co.

Meters

Steam-flow air-flow .....Bailey Meter Co., Ltd.
Flue-gas temperature recorders.....Bailey Meter Co., Ltd.
Draft gages .....Bailey Meter Co., Ltd.
CO_2 recorders, Ranarex .....Permutit Co. of Canada, Ltd.
Temperature recorders .....Bristol Co.
Flow meters, Republic.....Dominion Flow Meter Co., Ltd.

Vacuum Cleaner

Manufacturer .....Allen Billmyre Co.

Electrical Equipment

Motors .....Crompton, Parkinson, Ltd.
Motors .....Canadian General Electric Co., Ltd.
Motor control .....Allen West Co., Ltd.
Motor control .....Canadian General Elec. Co., Ltd.
Motor control .....Canadian Westinghouse Co., Ltd.
Motor control .....The Rowan Controller Co.
Transformers .....Ferranti Electric, Ltd.
Rating, four 700-kva., single-phase, 6,600- to 550-volts.
Type .....water-cooled
Oil switches .....Canadian Westinghouse Co., Ltd.

Building

Masonry: red brick, 12-in. walls; 2-in. gunite roof with tar and gravel covering; general contractor, Domill Construction Co. of Canada
Piling, 20-in. concrete.....Raymond Concrete Pile Co.
Steelwork .....Canadian Vickers, Ltd.
Sash, steel .....David Lupton's Sons Co.
Grating floors, Irving Subway, Type M, Crowes' Iron Works, Ltd.

boiler room and continues to a sump outside, from which the ash is removed by a grab bucket to trucks, and the water is recirculated through the sluicing system.

Bent-tube boilers with a water-heating area of 13,400 sq.ft. are installed. They are made up of four drums connected by 3¼-in. tubes. Gas flow through them is arranged in three passes, a bare-tube convection superheater being placed between the first and second passes. Normal working pressure is 200 lb. per square inch. Each boiler will generate 117,000 lb. of steam per hour at normal rating and each is designed for a peak load of 136,000 lb. At normal rating the flue-gas temperature will be 625 deg. F. when operating with 14 per cent CO_2. At that rating the steam is superheated 60 deg., a higher superheat not being desirable inasmuch as the steam is used principally for process work. The only steam used for power is that delivered to the turbines operating paper machines.

Flue gases from the boilers pass through tubular-type air heaters containing 17,820 sq.ft. of heating surface. Gases from the air heaters flow to a common flue on the ground level. Three induced-draft fans, above the flue, deliver the gases to the stack. The forced-draft fan for each unit is on the upper floor of the boiler room, about 25 ft. above the air-heater inlet. This distance permitted construction of the connecting ducts without abrupt change of section, assuring even distribution of air across the full width of the heater.

The air heaters are calculated to reduce the flue-gas temperature from 625 to 340 deg. F. and heat the combustion air from 70 to 415 deg. F. Preheated air is used in the pulverizers for mill drying of coal and is introduced as secondary air at the burners. It is estimated that these steam generators will have a continuous overall efficiency during normal operation of 82.5 per cent.

All control apparatus and instruments are mounted on panelboards located between each pair of boilers. It is possible to observe the boiler water level, also the flow of coal from the bunkers to the pulverizer feeders, from the operator's station.

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Automatic Elevator for Parking Automobiles

THE PROBLEM of handling automobiles in garages by elevators has never been satisfactorily solved. Because of congested conditions and limited elevator service, delays in car deliveries are frequently experienced. A plan for correcting this condition is suggested in a new type of elevator, or, as it is called, parking machine. This machine, which allows parking 24 automobiles on a ground space little larger than that required by an ordinary double garage, has been developed recently by H. D. James, consulting engineer of the Westinghouse Electric & Manufacturing Company. Cradles, one for each car, are supported between two endless chains which pass over sprocket wheels at the top and bottom of travel, as shown in the model, Fig. 1. The chains are driven by two electric motors, and, by means of a push-button control, or its equivalent, any cradle can be brought quickly to the driveway level for receiving or discharging an automobile. Six automatic machines of this type with an aggregate capacity of 144 cars, Fig. 2, have been installed at the company's East Pittsburgh works.

Three general methods, all of which employ substantially the same control but have different master switches, are used for operating the parking machine.

First there is the key system, best suited for garages where the spaces are rented for a fixed time. Outside the garage is a panel with numbered locks for each parking space, and a lock for opening and closing the door.

The parking machine may also be operated by push-button control, a method especially suitable for use in a public garage, where the push button can be located in the cashier's office. A third method, the coin system, is the same as the push-button control, except that a coin machine is used instead of push buttons. Depositing a coin opens the door and provides a space for parking the car.

Each machine of twenty-four parking spaces is 105 ft. high and occupies a ground area of 16x24 ft. for an automobile 18 ft. long. When desired, a lesser or greater number than 24 cradles may be used, with each pair of cradles omitted or added the structure being changed 8 ft. in height. The parking machine is adapted to many uses, among them being merchant garages for the convenience of customers of department stores, market houses and other merchandising establishments; and garages for tenants of hotels, apartment houses, clubs, office building, etc.

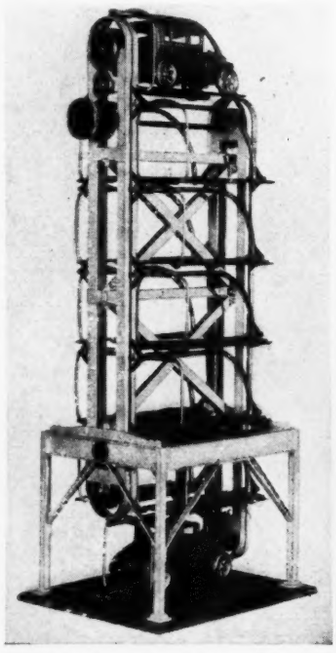


Fig. 1 — Model of parking machine, showing details of construction

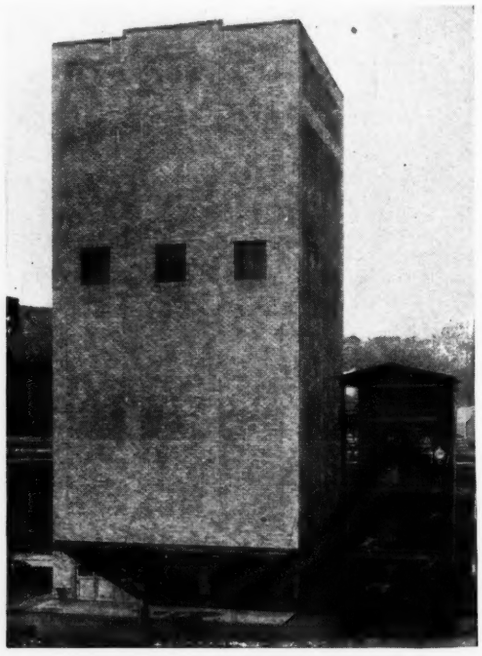


Fig. 2—Six automatic parking machines installed in this building provide space for 144 cars

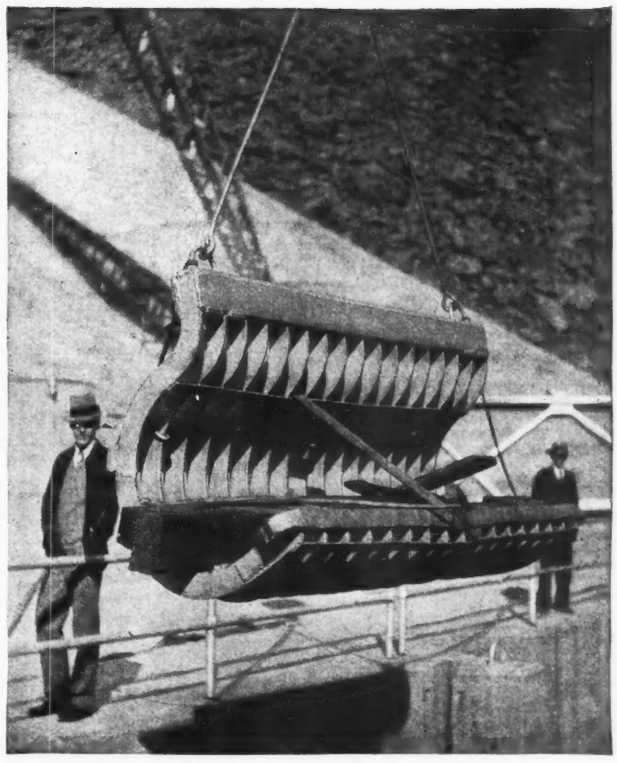
Trash Rake Cleans Racks In Deep Water

By J. ELMER HOUSLEY
Superintendent
Tallassee Power Company

A SIMPLE and convenient arrangement for cleaning the trash racks at two large hydro-electric plants in the South was provided by the design of a finger-type rake developed by the hydraulic department of the Aluminum Company of America. The rake is used on both the vertical and the inclined type racks.

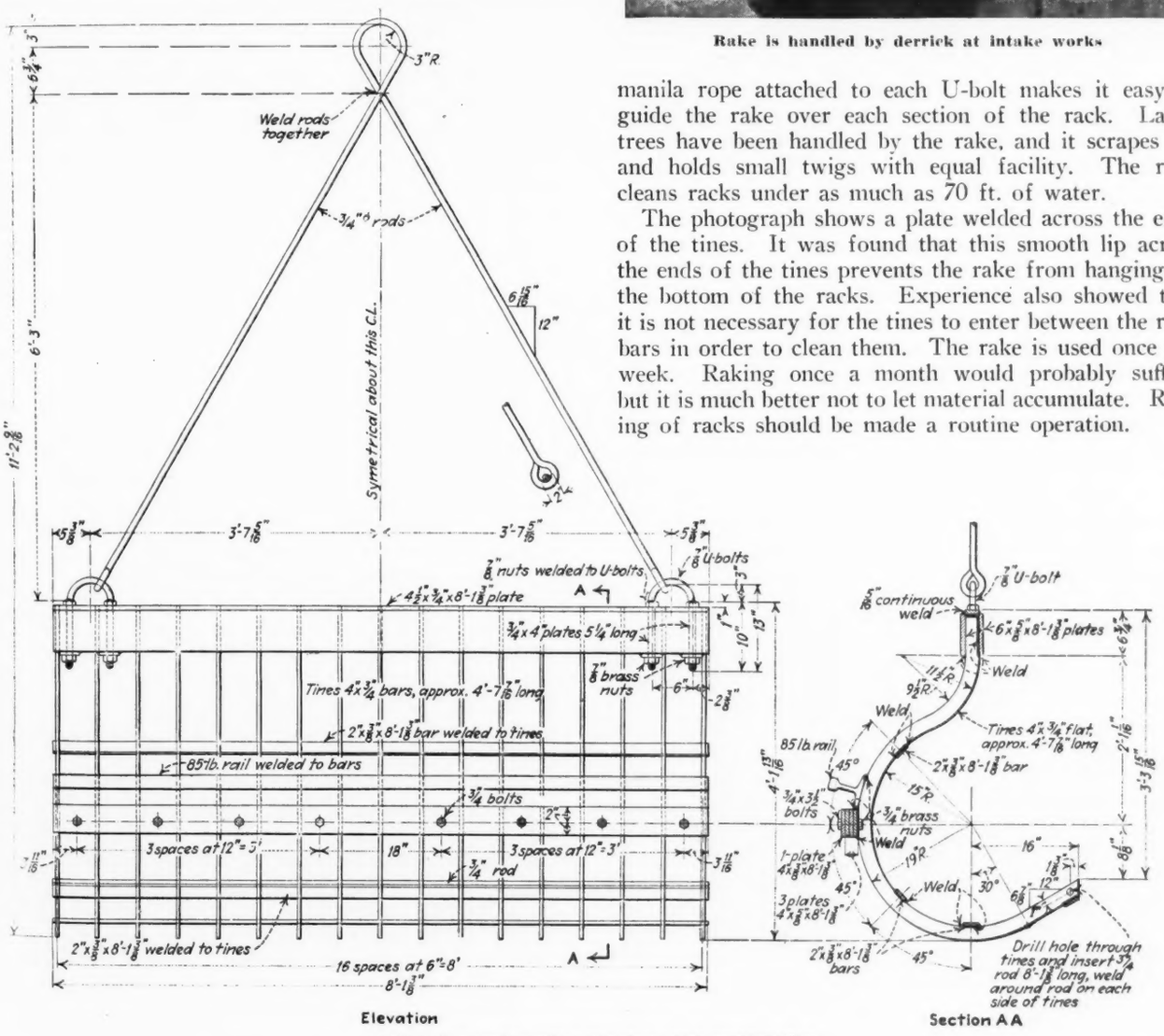
The rake is of welded construction, as shown in the figures, which also show the dimensions and structural details. A counterbalance is welded to the back of the rake, and the amount of weight was determined by experience in the field. It now consists of four 4x$\frac{5}{8}$-in. bars plus one length of 85-lb. railroad rail.

The rake weighs approximately 1,800 lb. and is handled by the derrick at the intake headworks. A $\frac{1}{2}$-in. manila rope attached to each U-bolt makes it easy to guide the rake over each section of the rack. Large trees have been handled by the rake, and it scrapes off and holds small twigs with equal facility. The rake cleans racks under as much as 70 ft. of water.



Rake is handled by derrick at intake works

The photograph shows a plate welded across the ends of the tines. It was found that this smooth lip across the ends of the tines prevents the rake from hanging on the bottom of the racks. Experience also showed that it is not necessary for the tines to enter between the rack bars in order to clean them. The rake is used once per week. Raking once a month would probably suffice, but it is much better not to let material accumulate. Raking of racks should be made a routine operation.



Elevation and section showing rake construction

In the see-saw of friendly technical competition between marine and stationary power engineers, the former have, for the moment, assumed the lead in the field of welded boilers. To date the United States Navy has ordered 38 boilers with all-welded drums. Here are some of the facts

Stack of welded drums for scout cruisers

U. S. NAVY steps out with WELDED BOILERS

LATE LAST YEAR came the announcement that the Bureau of Engineering of the United States Navy Department had ordered 24 welded-drum boilers for three new scout cruisers, the Minneapolis, New Orleans and Astoria. To power engineers on land, who have looked upon the Bureau of Engineering and the United States Navy Department as ultra-conservative bodies, the sudden vision of the navy leading the field in this new development came as something of a surprise. The A.S.M.E. Boiler Code Committee had been working for a long time on a code for the fusion-welding of boiler drums. A tentative code had been prepared and published, but none had been officially sanctioned at the time this order was placed. In fact, the welded boiler code still awaits final approval.

However, the work of the committee was one of the factors that made these boilers possible, for the specifications upon which they were ordered follow closely the proposed A.S.M.E. code specifications published in the March, 1930, issue of *Mechanical Engineering*. In the opinion of the Bureau of Engineering, and of the Babcock & Wilcox Company, which received the order, these specifications remove any question as to the safety of the welded drums.

Thirty-eight Boilers Ordered

It is worth noting that the original order of 24 boilers for the three scout cruisers, Minneapolis, New Orleans and Astoria, has been increased to 38 by the order of eight boilers for a fourth scout cruiser, and of six for the aircraft carrier CV4.

Before discussing the specifications under which these boilers are being welded, attention should be called to interesting features of the design. The cross-section reveals an unusual arrangement of tubes, headers and drum. The boiler is of the sectional express type. Note the use of vertical drums instead of ordinary headers. This saves weight, a tremendously important consideration in cruiser construction under present treaty limitations. Note also the uniform curvature of tubes.

The boilers for the scout cruisers each contain 10,900 sq.ft. of heating surface. Their drums have a diameter of 48 in. and are 13 ft. 6 in. long, with wall thickness of $1\frac{7}{32}$ in. For the airplane carrier each boiler has 7,680 sq.ft. of heating surface, with 48-in. drums 11 ft. long. The wall thickness is $1\frac{1}{4}$ in. All of these boilers, counting both scout cruisers and airplane carrier, are to operate at 330 lb. gage and 150 deg. superheat.

Elaborate Tests Required

Power has already published an article on the boiler-drum welding technique developed at the Barberton works of the Babcock & Wilcox Company. Something should be said here regarding the minutely detailed requirements of the specification. This specification, as already pointed out, is modified but slightly from that proposed by the Boiler Code Committee of the A.S.M.E.

Reviewed briefly, the specification requires welded specimens for testing made as a continuation of the actual drum weld. It requires elaborate tensile, chemical, impact, bending and other tests. It requires stress-relieving of the whole structure by heat, and in all tests emphasizes the factor of ductility of the weld metal. Finally, it requires photographic X-ray examination of all portions of the weld, with submission of the X-ray photoprints to the inspector as a permanent record of

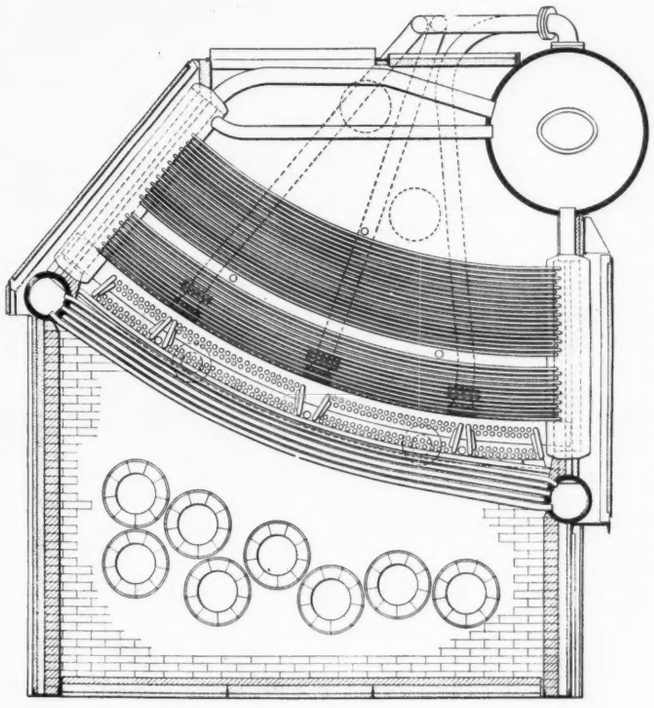
quality. A hydrostatic test completes the requirements.

To simulate in certain test specimens the conditions actually existing when welding, two plates for a test weld are arranged as a continuation of the drum plate, and the longitudinal drum weld is continued to join these two plates. These are later heat relieved with the drum before being cut up for testing.

Provision is also made for testing girth seams joints in drums where there are no longitudinal joints. This is done by removing 4-in.-diameter test plugs from the circumferential joint. Where such plugs are removed, later closure and reinforcement of the hole is, of course, necessary, and this is provided for in the specification.

The temperature specified for stress release, and the time of heating, varies with the thickness of the vessel. For 1¼-in.-thick drums it is required that the drum be heated to a temperature of about 1,100 deg. F., that at least 1¼ hr. shall be used to attain this temperature and that the drum be held at this temperature for the same length of time. Finally, the drum is allowed to cool slowly in still air.

It is impossible to read the specification without being impressed with the elaborate provision for the testing of physical specimens. For example, the longitudinal welded test plates are cut up for specimens to be tested in tension, impact and bending, also by macro- and micro-examination. Where test plugs are removed from circumferential joints, specimens are also removed for tension and impact tests, and for macro- and micro-examination.



To save weight vertical drums replace the customary tube headers.

Along with the more elaborate tests is included the simple but valuable bend test. A piece of rectangular section, crossing the weld at right angles, with the weld machined flush with the plate, is bent freely until the outside fibers are elongated at least 30 per cent. At this elongation no surface cracks exceeding 10 per cent of the specimen width are permitted.

More elaborate are the impact tests. Three separate samples are cut from the weld section, one of the upper metal, one of the bottom, and one of the middle section. Each of these is notched and subjected to the Charpy impact test. The specification requires a minimum value of 20 ft.-lb standard A.S.S.T.

All Joints X-Rayed

At present there is much discussion regarding the necessity of X-ray tests of boiler drums and grade A welded vessels. However this matter may ultimately be decided by the Boiler Code Committee, such tests are required by the navy specifications and are being made on all of the boilers ordered. Pictures of the X-ray apparatus used at the Barberton works of the Babcock & Wilcox Company have already been shown in *Power*.

The X-ray tube is mounted in a lead-covered metal drum provided with a suitable window so that the rays reach only a limited region along and on each side of the welded seam. Auxiliary lead shields prevent danger from the scattering of X-rays into the neighborhood. The film, cut to a convenient size, is placed near the inner surface of the vessel, directly opposite the window, and shielded with lead to prevent the escape of both direct and scattered X-rays.

The safety drum X-ray power plant and controls are mounted on a truck or car, which can be moved along the vessel for examination of successive sections of the longitudinal seams. The vessel can be rotated about its axis for rapid and convenient examination of girth seams.

For wall thickness of two inches or more the voltage applied to the X-ray machine is about 210,000, the exposure being chosen to give a satisfactory picture. For thicknesses below two inches a fixed exposure time of two minutes is used, and a reduced voltage is chosen to fit the thickness.

The history of these navy boilers is an interesting example of the interplay between marine and stationary power engineering. As already pointed out, the work of the Boiler Code Committee led to specifications which made these boilers possible. Conversely, it is clear that this marine advance must definitely accelerate the acceptance of welded boilers on land, and that experience with them will undoubtedly influence the design and construction of land boilers.

This article is based in part upon material furnished by the Babcock & Wilcox Company, with the approval of the Navy Department Bureau of Engineering, in part upon information previously published in *Power* and in part upon a paper delivered by J. C. Hodge before the recent annual meeting of the American Welding Society.

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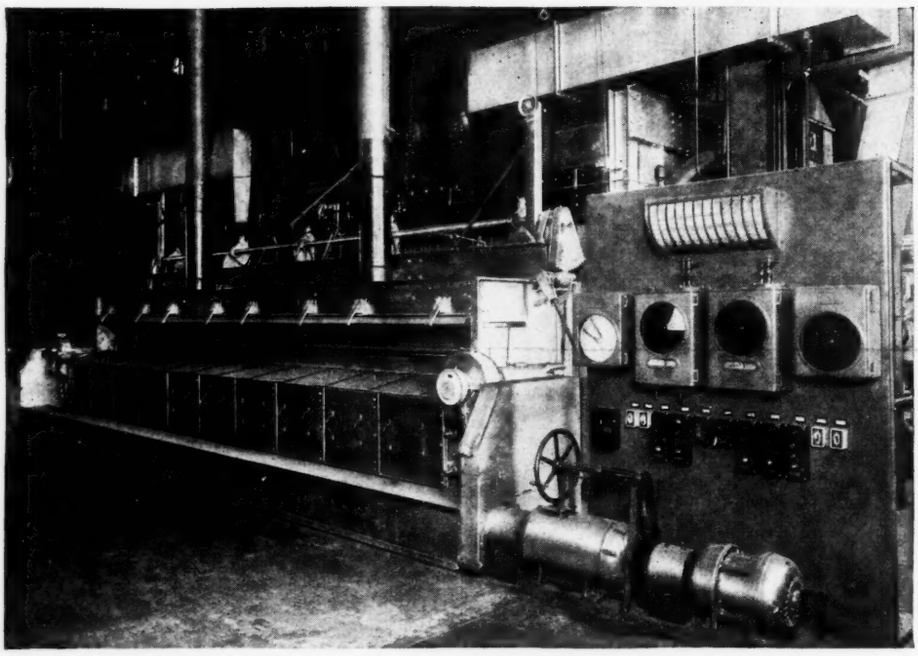
Inarticulate Engineers

By S. I. PHILLIPS

The engineer, like the scientist, has the difficult problem of making himself understood. This is not an easy matter. Professional popularizers in magazines and on the platform are too often woefully deficient in knowledge—and sometimes in intellectual honesty. At the other extreme is the engineer so saturated with his subject that he exudes technical jargon. He is generally right in his conclusions, at least on strictly engineering matters, but he cannot dent the popular mind, which must so largely determine political action in a democracy. The public in general would insist on wise action if it could recognize wisdom when it saw it. But the gift is rare.



New boiler unit equipped with forced-draft chain-grate stoker, 24 ft. wide

Improved Design Increases Steam Capacity And Efficieny With Iowa Screenings

These gains by a new boiler and forced-draft chain-grate unit were made possible by analyzing a series of tests at different ratings on the older units, adjusting relative capacities of the auxiliaries, and studying furnace design from maintenance records and inspections

FOR FIVE YEARS the Des Moines Electric Light Company has been burning Iowa screenings on forced-draft chain grates with results considered satisfactory. Recently an additional boiler designed by the company's own engineering department and installed under its supervision showed such improvement over the older installations that the analytical reasoning applied to the design may prove of value to others confronted with the problem of burning these low-grade, high-moisture coals.

When it became apparent that increasing load would demand additional boiler capacity, tests were run on the existing boilers to determine whether improvements could be incorporated in the new design. Iowa screenings from a number of different mines, all within a radius of 50 miles of the power station, was the fuel burned. An average of hundreds of coal samples that had been taken showed the following analysis, as fired: moisture, 20; ash, 18.90; volatile, 28.7, and fixed carbon, 32.40 per cent. Sulphur averaged 5 per cent, and the B.t.u. per pound 8,664.

In the columns at the left in Table I are shown some of the data from maximum capacity runs. From these tests the need of a larger induced-draft fan was established. As there was at the maximum rating a difference of about 70 deg. between the final gas temperature and the temperature of the air leaving the preheater, if higher capacities were to be obtained without a considerable dropping off in efficiency, a larger air heater also was indicated.

Considering the quality of the coal burned, it was thought that for a stoker of the size, the combustion rates obtained were satisfactory, so that for greater capacity a larger stoker should be used. In going from a combustion rate of 50 to 57 lb., the combustible in the ash showed considerable increase. A combustion rate of 50 lb. of coal per square foot was therefore assumed for the new stoker.

As space already had been provided in the building for a sixth boiler, the location of the building steel practically fixed the size of the boiler, namely, 15,000 sq.ft. of steam-making surface.

A study of the furnace design, both from the maintenance records and from inspection during tests, indicated that some improvement could be made, one of the principal difficulties being inadequate, non-uniform furnace temperatures at normal rating. Some maintenance had been required on the arch and portions of the side walls. Also, the rear wall did not reach a temperature high enough for best combustion efficiency except at high ratings. The load on the station is such that at times four boilers operating at 250 per cent rating are

required for the peaks, while three boilers operating at rating are sufficient for the light-load periods, which occur every night. The problem was therefore to provide a furnace suitable for low ratings on which the maintenance would not be excessive at high ratings. The cross-section shows the original stoker and furnace layout at the right and the new installation at the left.

With these points established the design was started. The larger induced-draft fan offered no difficulties. While the older fans were driven by a single variable-speed motor, the new fan has two constant-speed motors, the smaller motor running at 900 r.p.m. and intended for use up to 300 per cent boiler rating, while the larger motor, running at 1,200 r.p.m., is for use at ratings above this point. Flexibility is obtained through the use of adjustable vanes.

It had not been possible to run the forced-draft fan at more than 80 per cent of its maximum speed, owing to the limitations of the induced-draft fan. Since the new stoker would require less windbox pressure, it was decided to duplicate the forced-draft fans in use.

The stoker finally selected was made 1 ft. wider and 3 ft. longer than those already in use, giving a grate 24 ft. wide x 23 ft. long from the feed gate to the center of the rear shaft. This resulted in an effective grate area of 528 sq.ft., an increase of 18 per cent over the previous stokers. To accommodate the increased volume of the air preheated to a higher temperature, greater air space was left in the chain, and to provide better distribution of air under this larger stoker the entire air space between the two strands of the chain was made a common air chamber, with large openings into the windboxes, and individually operated dampers next to the upper strand for controlling the air for each 2 ft. of stoker length.

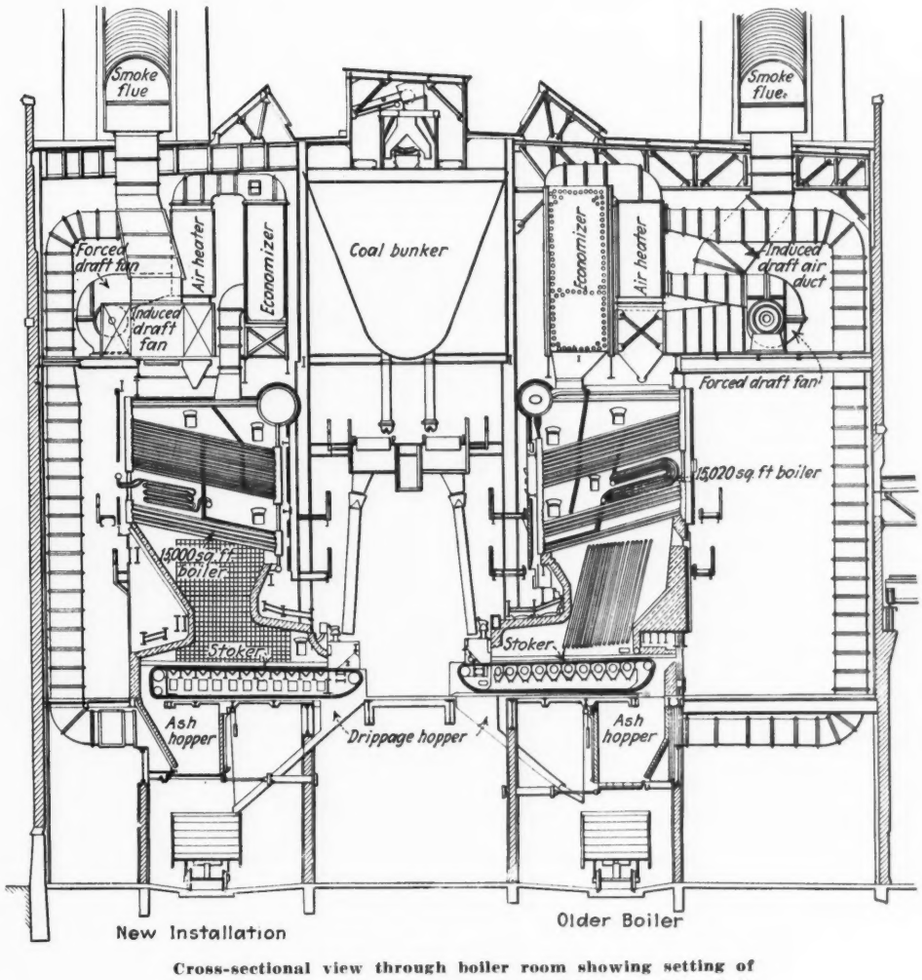
Maintenance on the front arches of the older units indicated that in the new setting this arch should be raised and shortened. With too low a temperature at the rear wall the logical course was to bring this wall toward the front of the furnace by dispensing with the water-cooled rear-wall support and using a rather long, suspended arch instead.

To eliminate the side wall maintenance it was decided to use a greater area of water-cooled surface and to protect the tubes from the direct action of the fire by using a facing of cast-iron blocks. Where the purpose of the water wall was simply to reduce maintenance, the blocks were faced with refractory material, on the theory that the refractory would burn off until the point was reached where the heat would be carried away by the tubes as fast as the blocks absorbed it, so that no further erosion would occur. Where the purpose of the water wall was to absorb as much furnace heat as possible, the blocks were left plain.

In Table I the columns at the right show the results secured from the new installation at the maximum rating obtainable. Coal used on this test contained slightly less ash, with corresponding higher B.t.u. content than the average. A comparison of the two heat balances shows the extent of the improvements. It should be borne in mind that both of these tests represent maximum-capacity runs, and that any change in conditions would be reflected at once in the steam output. However, the results are comparable, and if it is assumed that the steam output of the older boiler is, say, 10 per cent higher than the average, the same assumption applied to the output from the new boiler will still show the new installation capable of producing at least 30 per cent more steam.

At maximum rating the stoker was running at its highest speed, namely, $9\frac{3}{4}$ in. per minute. To burn more coal it would be necessary to use a thicker fuel bed, and this, by offering more resistance to the flow of air, would decrease the output of the forced-draft fan. Ignition, apparently, is not a limiting factor, as the coal lighted promptly at the feed gate at the maximum stoker speed, and the entire furnace appeared to reach a satisfactory temperature for best combustion efficiency.

Inspection of the furnace at different ratings showed



Cross-sectional view through boiler room showing setting of older boilers at right, and the new installation at the left

no dead pockets nor any tendency to erosion or melting of the refractory at any point. The appearance of the nose of the rear arch indicated that the water walls have a slight cooling effect along the sides of the furnace for a distance of about 2 ft. from the surface of the wall, as compared to 6 ft. in the older furnaces. The hottest point in the furnace, as evidenced by the appearance of the refractory, is the nose of the rear arch, although it appears that this arch will last indefinitely. The erosion experienced on the front arch in the other boilers has been eliminated.

Operation Greatly Improved

Operation at capacities from 100 to 200 per cent boiler rating has been improved greatly, and owing to the higher furnace temperature obtained at low ratings the unit responds to changes in load much more quickly than the older installation. The more highly preheated air, in so far as can be detected, has no detrimental effect either on the fire or the stoker.

It was anticipated that the long rear arch would reduce the combustible content in the ash, especially at high ratings. While the data show lower combustible content in the ash, it is impossible to say whether this is caused by the arch or by the greater capacity of the induced-draft fan. At capacities up to 250 per cent boiler rating no difference is discernible in the ash from the two types of furnaces. The heat balance on the new setting at maximum rating is similar to the heat balance on the older furnaces at a lower rating. Over-all efficiencies at maximum ratings increased from 78 to 83 per cent.

TABLE I—TYPICAL RESULTS FROM MAXIMUM RUNS ON OLD AND NEW BOILERS

	Older Boiler	New Boiler
Coal per hr., as fired, lb	25,200	31,400
Coal, per hr., dry, lb	20,160	25,120
Water evap. per hr., lb	144,000	190,000
Boiler rating, per cent	312	415
Temp. stack gases, deg. F	310	272
Temp. air leaving preheater, deg. F	240	265
Temp. water to econ., deg. F	200	215
Temp. water from econ., deg. F	300	321
Temp. steam from superheater, deg. F	700	736
Steam pressure, lb. abs	386	386
CO_2 top first pass, per cent	14	16
CO_2 top third pass, per cent	14	15
Combustible in ash, per cent	20	11.5
Main windbox press., in. water	+1.90	+0.70
Draft over fire, in. water	—0.10	—0.50
Thickness fire, in	6	7
Speed f.d. fan, r.p.m. Max 865	705	865
Speed i.d. fan, r.p.m. Max. 640	640	1200
Combustion rate, lb. per sq.ft	57.1	59.5
Heat Balance		
	Per Cent	Per Cent
Loss from moisture in coal	2.65	2.57
Loss from hydrogen	3.92	3.72
Dry gas loss	5.53	4.19
Loss due carbon in ash	6.37	3.51
Absorbed by boiler, superheater and air heater	71.91	75.57
Absorbed by economizer	6.60	7.44
Unaccounted for	3.14	3.00
	100	100

TABLE II—MECHANICAL EQUIPMENT OF NEW INSTALLATION

Boiler, Walsh & Weidner, hor., cross-drum, sectional header, 15,000 sq.ft., 385 lb. press	Combustion Eng. Corp.
Stoker, f.d. chain-grate	Illinois Stoker Co.
Economizer, 7,560 sq.ft	Foster-Wheeler Corp.
Air heater, sectional-plate type, 13,660 sq.ft	Foster-Wheeler Corp.
Superheater, interdeck	Superheater Co.
Water walls, 318 sq.ft., Bailey refractory and smooth blocks	Fuller-Lehigh Co.
Arches, double-suspension, Mizzou blocks	Bigelow-Liptak Corp.
Fan, induced-draft, 113,000 c.f.m. at 11.7 in. suction, vane control; one 900-r.p.m. motor, one 1,200 r.p.m. motor	B. F. Sturtevant Co.
Fan, forced-draft, 78,000 c.f.m. against 4½ in. stat. press.; drive var.-sp. motor	B. F. Sturtevant Co.

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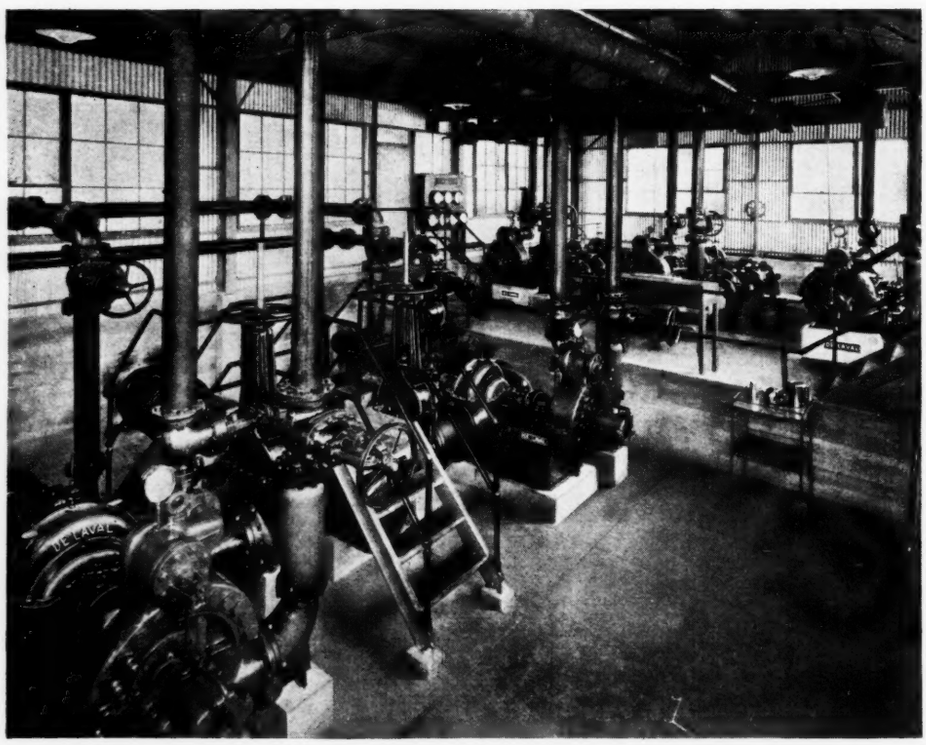
Another Gas Turbine Installation



Pump room of the Superior Oil Company's high-pressure absorption plant at Kettleman Hills, California, designed and constructed by C. F. Braun & Co., Inc. The De Laval turbines receive natural gas from Huffman No. 1 well at pressures around 275 lb., the back pressure varying from 75 lb. per square inch down to atmospheric. Some 15 or 20 of these gas-driven turbines have been installed in various Kettleman Hills refineries, one of which was described in POWER last week

High-Pressure Line Handles Exhaust at Low Pressure

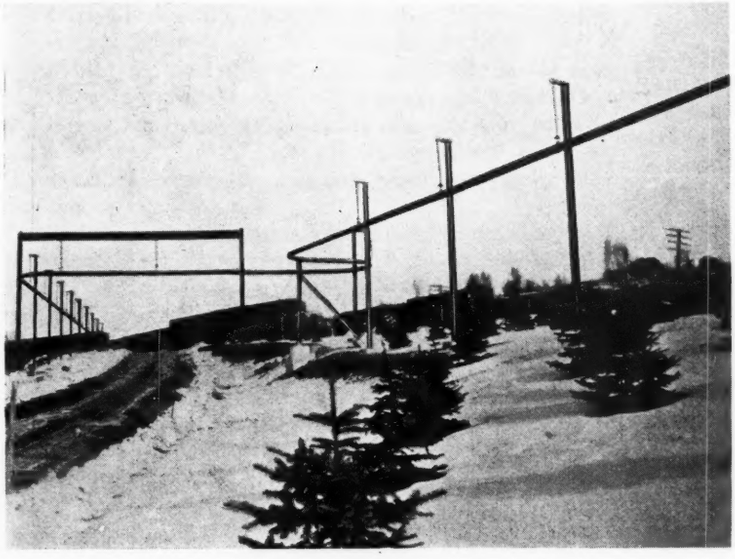


Fig. 1—The outdoor line (8-in.) is more than 800 ft. long

By SAMUEL M. GREEN
President, Samuel M. Green Company
Springfield, Mass.

Transmission line at plant of the Fitchburg Paper Company contained 1,091 ft. of 8-in. pipe. Built to carry high-pressure steam to engines in one of the mills, it was later used to carry turbine exhaust to the same mill without undue pressure drop. The engines were removed with a large saving in operating cost.

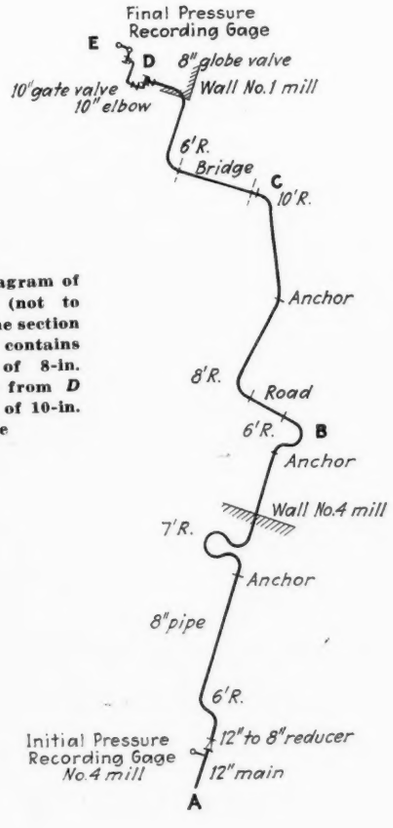


Fig. 2—Diagram of pipe line (not to scale). The section *A* to *D* contains 1,091 ft. of 8-in. pipe, that from *D* to *E* 25 ft. of 10-in. pipe

THE Fitchburg (Mass.) Paper Company in 1927 installed an 8-in. steam line between its No. 4 and No. 1 mills for the purpose of shutting down the No. 1 mill boiler room and supplying the steam to operate this mill from the No. 4 mill boiler room. The line carried 150 lb. pressure, supplying steam to two engines which generated current for the operation of that mill. Exhaust from these engines supplied the process steam for the mill at 12 lb. gage pressure.

The steam line was installed by the Jennison Company. All joints are welded. The insulation, furnished by Keasbey & Mattison, is double standard thickness of 85 per cent magnesia, one inch of hair felt, all covered with three-ply roofing paper cemented and held on with 16-gage copper wire.

No difficulties of any kind have been experienced with this line, and the yearly saving in labor and fuel has been not less than 50 per cent of the investment per annum.

The pipe line (see Fig. 2) starts from the end of a 12-in. header in the No. 4 mill boiler room at *A*, rises through two 6-ft.-radius bends and passes through the mill finishing room, where there is a double-offset expansion bend. The length of pipe from the 12-in. header to the No. 4 mill wall, including bends, is 256 ft.

It passes through the wall of the No. 4 Mill outdoors and is carried on steel posts, on 20-ft. centers, to *B*. The length to this point is 192 ft. It then turns nearly 90 deg. and is carried over a road on an I-beam and thence to *C*, a distance of 432 ft. From *C* it is carried on a light steel bridge, 130 ft. long, over a river and thence into the No. 1 boiler room, where it connects to a 10-in. tee. The length of the pipe from *C* to the

10-in. tee is 211 ft. The total length of the 8-in. pipe, including bends, is 1,091 feet.

Since the installation of this steam line further improvements in the operation of the No. 4 mill boiler room have been made. Studies of the use of process steam showed that a large amount of steam used directly from the boilers could as well be used at 25 lb. pressure. Consequently, if this steam were first passed through a turbine exhausting against that pressure, large amounts of power could be generated for much less than the mill was paying for public-service current.

Having decided to install a turbine at No. 4 mill to exhaust against 25 lb. pressure, it was apparent that if the 8-in. steam line, at that time carrying 150 lb. pressure, could deliver process steam to No. 1 mill, starting with a pressure of 25 lb. at No. 4 mill and maintaining not less than 12 lb. pressure at No. 1 mill, the No. 1 mill engines and labor to operate them could be eliminated, at an annual saving of about 40 per cent upon the required investment.

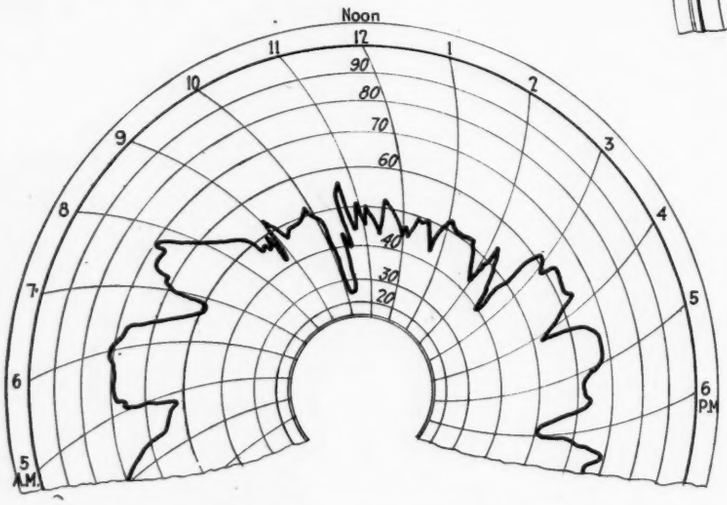


Fig. 3—Steam flow chart located in 8-in. line near *A*. Reading multiplied by 250 = pounds of steam

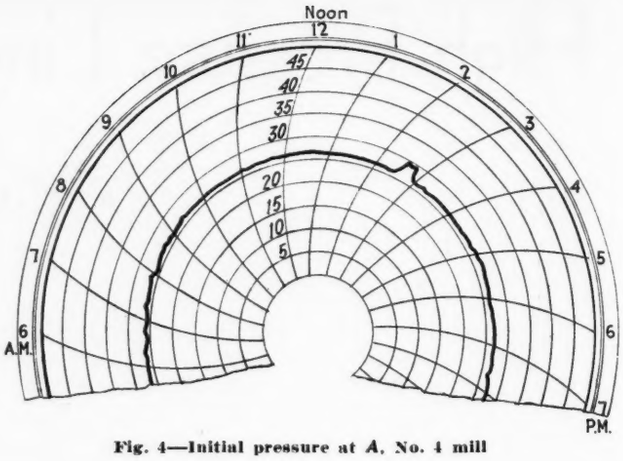


Fig. 4—Initial pressure at *A*, No. 4 mill

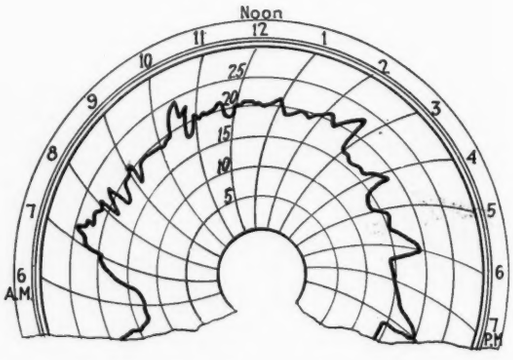


Fig. 5—Final pressure at *E*, No. 1 mill shows a minimum of about 13 lb.

Calculations by the writer showed that with an initial pressure of 25 lb., when the line was delivering 17,000 lb. of steam per hour, the final pressure would be 12.5 pounds. Other engineers were asked to check these figures, but their calculations showed somewhat greater loss.

It was decided to install the larger-sized turbine and take the risk of having to operate it against somewhat more than 25 lb. back pressure.

The only change required in the steam line was at No. 1 mill, where a 10-in. pipe was connected to the 10-in. tee and carried into the No. 1 engine room, and there connected to a large pipe header into which the No. 1 mill engines exhausted and from which all process steam was supplied.

The new turbine is now operating and the 8-in. steam line is supplying steam to No. 1 mill under the pressure and steam-flow conditions illustrated by Figs. 3, 4 and 5.

The maximum flow is from 5:15 to 6:00 a.m. and is at the rate of 17,400 to 17,750 lb. per hour. The initial pressure at this time is 26 lb. and final pressure 13 to 12.25 pounds.

600 Power-Research Projects

WHAT they are about—who is doing the work and where—what has been discovered and where results can be found—all this will be given in the twenty-four page table which will be a part of the Special Research Number of

POWER, MAY 26

Automatic Generators Prevent Power Outages

By D. C. HOFFMANN

Switchgear Department
General Electric Company

AT THE Ann Lee Home, in Albany County, N. Y., power for lights and motors is distributed to the various buildings of the institution by feeders from a 4,000-volt, 3-phase, 4-wire distribution bus in a substation on the premises. The bus is normally energized by an incoming line several miles long. To provide stand-by power during interruptions, two gasoline-engine-driven alternating-current generators have been installed in the substation.

The two units are under automatic control and no substation operator is required. If the voltage on the bus fails and remains off for a few seconds, one of the units is started automatically. The gasoline engine is cranked by a small starting motor operating from a 12-volt storage battery trickle-charged from the bus. As soon as the engine fires the motor is disconnected from the battery and runs under its own power. Quick starting is assured by an automatic choke on the engine. The cranking operation is similar to that of an automobile engine.

At the same time that the engine is started the incoming line oil circuit breaker and the power feeder breaker are tripped so that the bus is in condition to be energized by the generator. All lighting feeder breakers remain closed. A remote alarm bell is rung to call attention to the power having failed and that the emergency unit is being started.

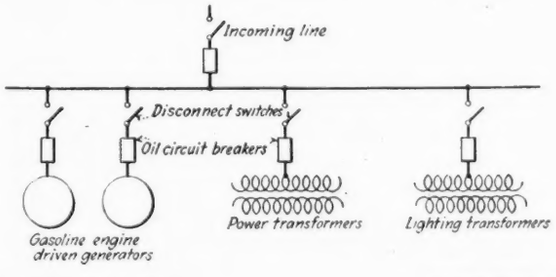
The engine is brought to normal speed and the small direct-connected exciter builds up its voltage. Field is applied to the generator, and the alternating-current voltage is held at the proper value by a voltage regulator. The frequency is maintained substantially constant by the speed governor on the engine. As soon as the speed and voltages are normal, the generator is connected to the bus and load by the closing of the generator breaker.

The control is so arranged that the second unit does not start automatically unless the first one fails to start. The attendant, summoned by the ringing of the remote bell, can, however, start the second unit by means of a control switch if he considers it necessary. This unit is synchronized manually with the first machine. The power feeder that was tripped when the first unit started can be reclosed manually at any time after the machine has started. The engines and generators are protected against all abnormal operating conditions by automatic relays.

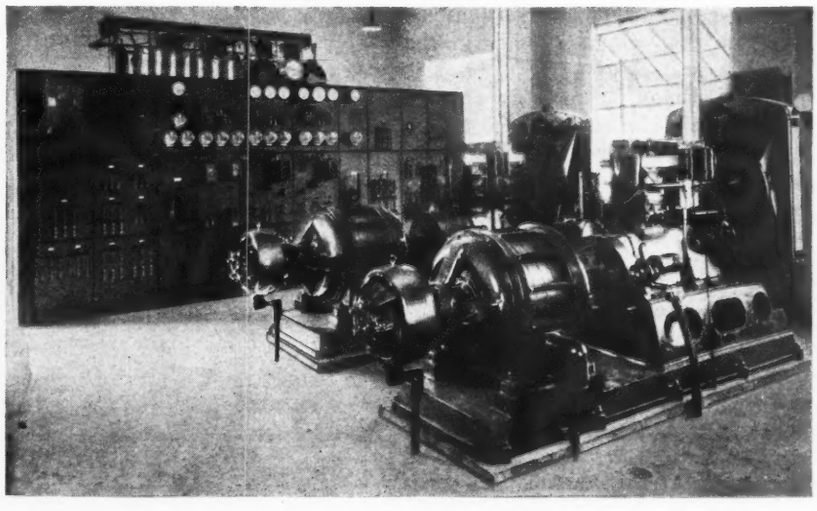
Both units are shut down automatically within a short time after the incoming line voltage is restored to normal. As soon as both generator breakers are open, the incoming line breaker is closed, and all of the feeders are energized again from the normal source of power. To protect the starting battery the cranking period for the engines is limited to a definite maximum. If the cranking time has not been excessive, additional time is allowed for the rest of the starting sequence to be completed.

Automatic control can be designed to perform in any desired manner. Starting indications for either unit can be given, in response to a failure of bus voltage, by means of a time switch, a load-demand indicating device or by supervisory control. Automatic synchronizing relays can also be used if it is necessary to synchronize the generator with the bus or with another generator automatically. Protection against all the usual abnormal operating conditions, such as alternating-current overcurrent, overheated machine winding, overheated bearings, overspeed and overheated engine, can be provided.

Although the foregoing description is of a particular equipment exemplifying the general type, of which several have been installed, these units and this type of automatic control are suitable for various other applications. Gasoline-engine-driven generators can be used for emergency or stand-by power for prisons, hospitals, rural electrification projects, small towns, large buildings, and many industrial or manufacturing plants where the duration of power interruption must be kept to a minimum.



Above — One line diagram of substation circuits



Right — The two gasoline-engine alternating-current generators supply emergency service to a 4,000-volt 3-phase system. One of the units starts and comes onto the system automatically in case the main power source fails

Hand Scraping of Oil Engine Bearings

By L. H. MORRISON
Associate Editor of POWER

TRADITION rules engineering as well as people. The Turkish farmer still employs the wooden plowshare simply because it has always been used. The average American refuses to take to aviation since it has not the authority of age. The manufacturer of machinery, in spite of his boasts, adheres to obsolete bearing-fitting methods, simply because James Watt employed them in the lack of better ways.

According to many engineers, the present general acceptance of hand scraping of bearings of oil and gas engines is not justified in view of the accuracy obtained in modern machine tools. Certainly in the days of Watt, Hornblower and Stephenson, when the lathes and other cutting and boring tools were so inaccurate that a journal was considered perfect if not over one-quarter inch out of round, engine makers were forced to hand scrape bearings to fit them to the unsymmetrical journals.

But why insist upon an expensive hand process when the modern machine will do the work more accurately and cheaply?

In a typical oil-engine shop the top of the bedplate is machined true as is possible on a larger plane, which, of course, is not perfect in its alignment and so introduces errors, intensified by the lack of rigidity in the engine base itself.

The housings, or recesses, for the bearing shells are finished with a long boring bar provided with a cutting tool. This bar is not rigid enough to be unsupported its entire length, which entails the use of brackets resting upon the planed surface of the bed.

. A better device would be a diamond-pointed fly cutter, a modification of the boring bar, which revolves at high speed and takes a light cut. The lightness of the cut reduces the tendency of the tool to spring away from the work. Unfortunately, fly cutters are expensive and are prohibitive for the manufacturer who builds an extensive line of engines with different shaft diameters.

Even with the inaccuracies of the engine-base top surface and the errors of the boring bar, a careful workman, with a modern tool, is able to bore all the bearing housings with a deviation from alignment perfection of not over ± 0.001 inch.

Other manufacturers, some as a result of forcing the work and others by reason of ancient tools, are satisfied with a tolerance of 0.002 inch, correcting the errors by scraping the housing or bearing shell.

How Some Types of Bearings Are Made

At present, journal bearings are made up of a steel or cast-iron shell and a babbitt lining. Some manufacturers place a mandrel inside the shell and run in the babbitt from a ladle, making the lining from $\frac{1}{8}$ to $\frac{3}{8}$ in. thick. Casting a lining with the shell placed vertically does not always insure an even distribution of the metal, nor is the babbitt always uniform in quality.

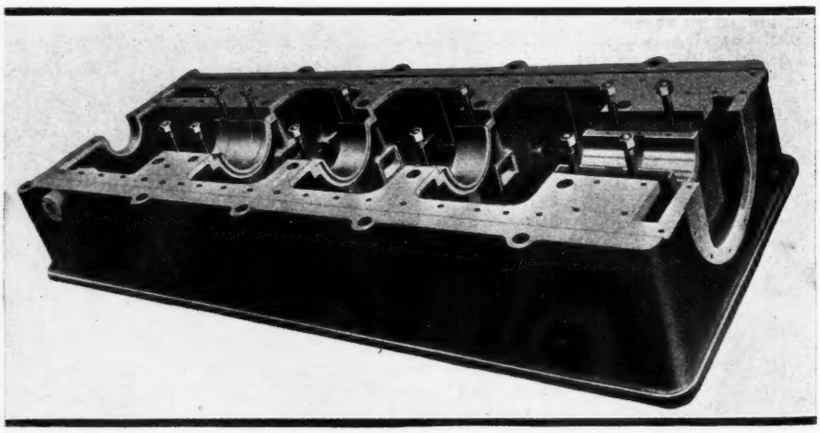


Fig. 1—An engine bed with the housings ready for the bearing shells

More modern shops cast the lining centrifugally. The shell casting is chucked to a rapidly revolving holder and the hot babbitt slowly poured in, with the result that the metal may be said to be spun on to the shell surface. To insure bonding, shell grooves may be employed. Other builders find that such anchors are undesirable and that the best bonding is obtained when the babbitt is spun on to a plain bored surface.

Less liberality of babbitt thickness exists than formerly; a thickness of $\frac{1}{16}$ in. gives long life and there is less creep, or squashing, of the thin babbitt.

After the shell is babbitted, the inner surface is bored true to a width of 0.0005 in. by a diamond cutting tool, or, in other shops, by a high-speed steel tool.

At the same time, the outer surface of the shell is trued, which should give a uniform thickness of liner and shell, the accuracy depending upon the tools and workmen.

At this point the shell must be cut into its two halves, whereupon any existing external strains will cause a half to either flatten at the parting edges or curl up. It is to compensate for this action that many engine builders proceed to scrape the shell to cause it to rest over at least 75 per cent of the housing. Even the housing may be hand scraped to insure complete contact, some workmen assiduously removing even the tool marks.

To avoid the deformations occurring when the shell is divided, a few manufacturers have adopted the procedure of separating the two halves before the babbitt is run. They are chucked on to a revolving faceplate to receive the centrifugally cast babbitt, which is then bored. To true the outer diameter with the babbitt bore, the shells are clamped on an arbor and the outer surfaces machined. Clamping, if the arbor is of the correct diameter, should not deform the shells, although that objection is sometimes raised against the method.

In fitting the shaft to the liner and the shell to the housing, the almost universal method is to blue the surfaces and hand scrape until contact is made over at least 75 per cent of the surface. The scraping of the babbitt is carried out to the point that a bridge gage shows a change of less than 0.002 in. when the shaft is revolved to any position.

Hand Scraping Unnecessary

If the machine work is properly carried out it is questionable that this hand scraping is needed. The chief engineer of one builder who has been successful in manufacturing engines turning 600 r.p.m., states that in his opinion a babbitted bearing surface should not be touched with a hand scraper except where it is necessary to remove sharp corners on oil grooves or to clear a fillet. A smooth-finished machine surface, especially one produced by a carballoy or diamond tool, is an ideal bearing surface, so he states, and it will operate with less wear and show more uniformly distributed load than the bearing that has been hand scraped even by the best mechanics. His company, therefore, no longer hand scrapes babbitt-lined bearings for its oil engines.

To obtain the accuracy required to make bearings interchangeable, and to make it possible to install them without hand fitting, it is necessary, in his opinion, to part the two halves before the bearing is completely finished.

On old equipment on which little money is spent in upkeep it is not possible to produce a job which needs no scraping, but good machines cost a lot of money these days, particularly the very large ones. They often stand idle at a fearful overhead. Whether a manufacturer wishes to produce an accurate job by a large machine expenditure or by a small machine expenditure and some outlay for hand work is no test of the final quality of his product, although it may be of the manufacturing economy.

Limitations Due to Small Output

If a shop builds enough engines to justify expensive accurate machines, hand scraping may be avoided. On the other hand, where only a few engines are built yearly, which prohibits proper tooling, hand work must be resorted to if the product is to be mechanically acceptable.

That skillful hand work to good master gages or plates is always more accurate than machine work is well known. Repeated reproduction of planer by planer and lathe from lathe without continuous hand correction would result in complete degeneration of our machine tools.

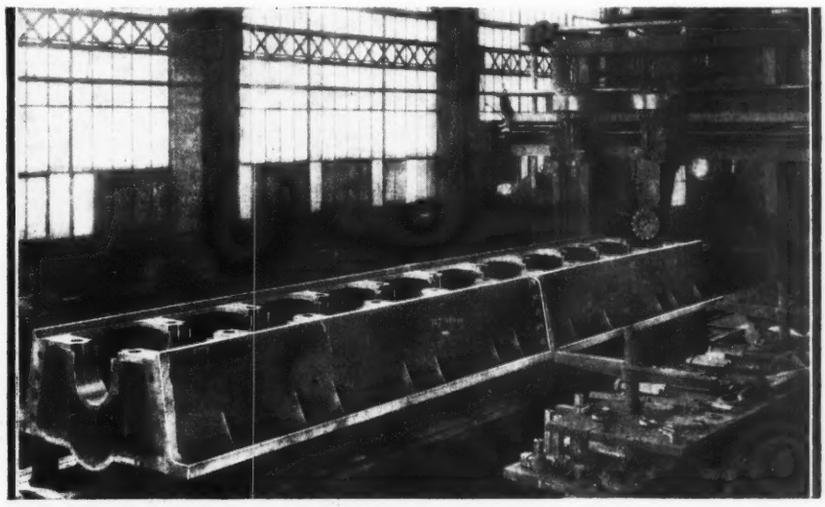


Fig. 2—Machinery housings of a 3,000 hp. diesel

Hand-Fitted Replacements Costly

From an engine-user's point-of-view, however, hand scraping has another aspect. If each replacement bearing must be hand fitted, some one other than the typical operating engineer must be called in. This entails expense and delay. When, for reasons of economy or from lack of proper appreciation of the difficulty of the work, an engineer unskilled in hand scraping attempts the fitting, bearing trouble may ensue. Hand scraping of renewal parts should not be necessary. One engine manufacturer has perfected bearing machinery to a point where replacements are put into railroad engines with no hand filling whatever. This reduces the idle time by at least a day, which, along with the elimination of the mechanics' wages, goes far toward covering the cost of the bearing.

Builders of large engines cannot adopt all the manufacturing methods of the automotive-engine factory, but the ability of the latter to discard hand scraping on engines running at 3,000 r.p.m. is significant.

. . . RIGHT OUT OF THE PLANT . . .

Auxiliary Relay Silences Alarm Devices

A BELL, horn or whistle is a common part of power station equipment to warn the operators of unusual happenings. One purpose of an alarm system is to advise the operator when certain protective relays function. Extra contacts or auxiliary relays provide means of connecting a reset to the alarm circuit to stop the sounding of the bell or horn. Some protective relays, however, cannot be reset immediately. An example is the thermal relay, which requires time to cool before it can be reset. In some cases a snap switch is connected in the bell leads by the switchboard men and they forget

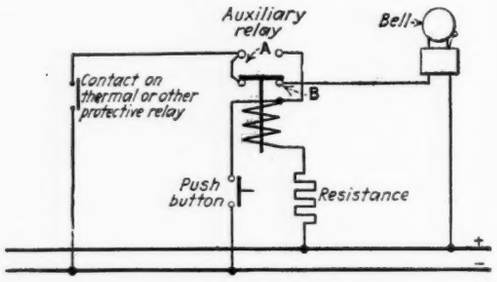


Diagram of alarm-cutout circuit

to close the switch after cutting out the alarm. To avoid this a relay and connection as shown in the accompanying diagram is recommended.

When the contacts of the protective relay close, the bell is energized through the *B* contacts of the de-energized auxiliary relay. The operator can immediately stop the bell's ringing by pushing the button. This closes auxiliary relay contacts *A* and completes a circuit for the relay coil through these contacts and the contacts of the protective relay. This operation also opens the bell circuit through contacts *B*. When the protective relay cools down or otherwise returns to normal, and its contacts are opened, the auxiliary relay is de-energized and drops back ready for duty again.

A. C. FINNEY,
Switchgear Department,
Philadelphia, Pa. General Electric Company.

Misapplication of Engineering Terms

THE LACK of discrimination shown in the use of technical terms in discussions of engineering topics frequently leads to misunderstandings. One word that is much overworked is "efficient." It is made to serve as a loose general substitute for "adaptable," "convenient," "effective," and various other adjectives whose connotations are narrow and explicit. When, for example, it is said that a 24-in. pipe wrench is a less efficient tool for making up a ½-in. pipe line than a 12-in. wrench, the statement is to be interpreted as meaning that the 24-in. wrench is the less convenient or adaptable tool.

In the terminology of engineering, the word "efficiency" properly serves the special purpose of expressing the idea of a ratio of output to input, as in the case of a steam engine, or of the ratio of some physical value between different members of a construction, as where boiler seams are considered. Used in this sense it carries the concept of better or worse, greater or less gain, and the like—the bigger the ratio the higher the efficiency, and vice versa.

Often the simple word "efficiency" may be used in a correct sense, but the qualifying adjective necessary to make its meaning truly explicit may be lacking. The purchaser of an electric transformer, for example, does not always have the right idea as to the meaning of this term when used with reference to the working of the machine he is buying. In this connection there are two kinds of efficiency to be considered—the power efficiency and the time efficiency. The power efficiency might also be called the instantaneous efficiency, for it is found by dividing the output by the input at any given instant. The time efficiency, on the other hand, also might be called the continuous efficiency, for it is found by dividing the output during the regular running period by the input during the same period. For the average factory plant, the time interval is about ten hours. Hence, where the transformer is to be operated under the usual conditions of a lighting load, the time efficiency is the item of greater interest to the purchaser.

The phrase "per cent regulation" affords another example of laxity in the use of engineering terminology. With reference to electrical machines, the word regulation usually implies increase or decrease of voltage between various stages of the load and no load. If, for example, the full-load voltage of a generator is 230 volts and a sudden dropping off of the load runs the voltage up to 235 volts, then the per cent regulation for full load is 2.13.

If the average practical man is told that the per cent regulation has been either increased or decreased, the chances are that he will construe "increased" as a

synonym for "improved" and "decreased" as a synonym for just the contrary term. Stating that the per cent regulation had been improved or impaired would leave no room for misconstruction.

Words often misapplied are "rotation" and "revolution." The flywheel of an engine, for example, does not revolve. To do that its entire mass would have to swing around some points external to itself. The motion we observe when the engine is running is the flywheel's rotation upon a horizontal line coincident with its center of gravity—assuming that the wheel is balanced perfectly. Neither does the crank revolve; it rotates upon the axis of the crankshaft. But the crankpin revolves; it swings in a circular orbit around the axis of the crankshaft. Hence we say that the engine makes so many revolutions in a given time interval.

Then there is the loose nomenclature which designates such mechanical agencies as the wedge, screw and lever as "powers." This interprets the term "power" in a misleading sense. Power is an active agency derived from the source of energy. The instruments by which it is transmitted are passive. They should, therefore, be styled "appliances" or given some other name synonymous with this term.

Another false construction is put upon the word "power" when it is used to convey the idea of work accomplished or of capacity for doing work, regardless of the time consumed. Time is the determining factor; it defines the rate of doing work and this is the measure of power.

D. J. ALLISON.

Chicago, Ill.

Personal Equation May Determine Engineer's Progress

HAVING READ the article by A. E. Pitcher in the March 17 number entitled "Personal Equation May Determine Engineer's Progress," I cannot allow some of the statements made by Mr. Pitcher to go unchallenged.

It is lamentable the number of men one meets today with the idea that it requires a pull or a push to get anywhere, when more often a pull or a push is in reality a boost in just the opposite direction.

Of a certainty the man who can mix well and converse well is the man who will be able to sell himself in preference to the fellow who cannot. Mr. Pitcher mentions a case where he landed a position through the recommendation of an engineer whose reputation was of the highest; all right, where did that engineer get his reputation—by pull? Not very likely, because the man who occasionally does hold an easy and responsible position by pull doesn't get that kind of a reputation. He also mentioned that upon leaving the university (did he get in that frame of mind at the university?) that he had the misfortune to work under one of these pull fellows. Probably and as is often the case if the men under this man would have spent less time criticizing the "boss" and more time in constructive and organized effort they would have received the recognition they felt was due them.

No, every man cannot be a genius, for if we were all elevated to the level of genius there would even then be some who would stand head and shoulders above the crowd, mainly because of their unselfish devotion to their work and service to men.

The statement is made that the man who employs an engineer is more interested in whom he knows than in what he knows. That is a new one to me. Must we all buy social registers instead of textbooks? Why does a man employ an engineer—to give him a push up the social ladder or to *pull* down his coal bill?

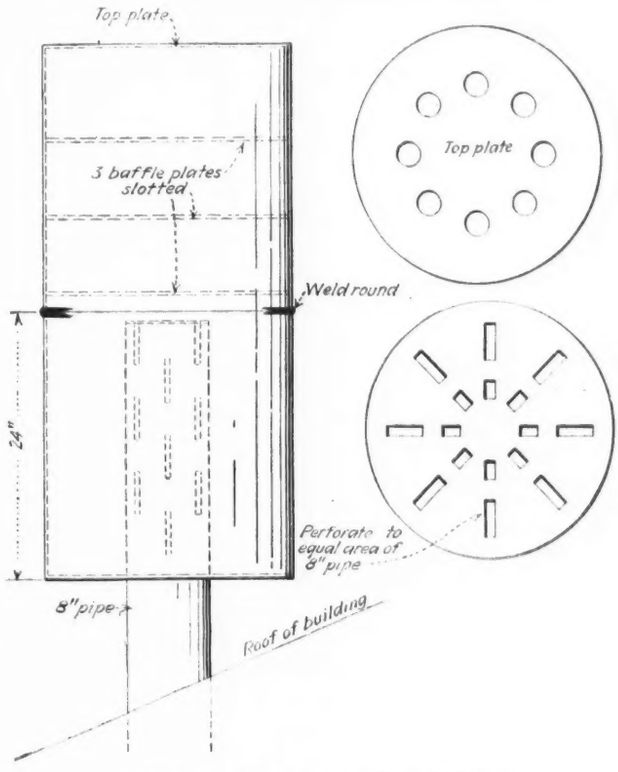
Washington, D. C. J. S. TOPP.

Silencing Compressor Muffler

OUR air compressor plant was situated more or less in the heart of the city and after further building had brought residents close to the plant we began to receive complaints about the noise made by the exhaust. We were in the position of either abating the noise or closing the plant. The former alternative was decided upon and was accomplished by adding another silencing head to the one already installed.

The existing exhaust muffler was made by slotting the top of the 8-in. exhaust pipe to equal the area of the pipe, and welding it into the head of 24x24-in. steel cylinder, the other end being left open.

A similar shell 24x24 in., of ¼-in. plate, was rolled up and seam-welded. In one end of this shell a ¼-in. plate was welded to form a head. In this head holes were cut, as shown in the upper detail view, to allow the gas to escape. Three baffles of the same size were welded inside at equal spaces, each being slotted to equal the area of an 8-in. pipe, with ½-in. x 2-in. slots.



Assembly of muffler and detail of baffles

This shell was welded on to the existing one around the circumferential seam. When the engine was again started the noise was reduced to a minimum, with no appreciable rise in back pressure.

Long Beach, Calif. M. C. COCKSHOTT.

Early American Steam Engines

I READ with interest the foreword on "Early American Steam Engines" which appeared in the Feb. 17 number. The accompanying illustration shows the ruins of the old engine house on the Schuyler copper mine in North Arlington, N. J.

About the middle of the eighteenth century the Schuylers built the road now known as Schuyler Avenue,

Ruins of old engine house of Schuyler copper mine

extending southward about three miles from their copper mine as an approach to the tidewater of the Passaic River and Newark Bay. The mine was the unattained objective of the British in the Battle of Schuyler Heights during the Revolution. JOHN F. GRACE.

Harrison, N. J.

Government Purchase of Foreign Diesels

IN THE April 14 number of *Power* H. M. Renner makes a comment in regard to diesel engines that in my opinion is open to question. He stated: "But while most of these engines are for stationary work, from an operation standpoint I can see no difference from marine operation."

While my knowledge of stationary practice is limited to information gleaned from such magazines as *Power*, I believe I am justified in assuming that the bulk of desiel power in shore plants, in sizes comparable with those installed in sea-going ships, is used to drive electric generators, pumps and compressors, under conditions where the individual units operate at nearly constant speed and uniform load.

It is obvious that the average diesel engine operating under such conditions is never called upon to withstand the stresses that a marine direct-drive diesel installation is subjected to during periods of stormy weather at sea, when the ship's propeller may be completely submerged one instant and revolving in the thin air the next. In fact, the reversals in hull-bending moments, coupled with the transverse stresses that occur, both caused by wave action and load conditions, create operating conditions unknown in stationary practice.

To design diesel engines that will satisfactorily meet marine conditions is a problem sufficient in itself to tax the ingenuity of our best designers; any attempt to use stationary practice as a basis of comparison simply tends to create confusion in the minds of persons not familiar with the problems involved.

If Mr. Renner had limited his comparison to diesel-electric drive as used in the marine field one could accept his statement more easily, though even then it would be open to question in many ways.

The greatest obstacle in the path of the marine diesel builder in this country is not lack of design and construction talent but lack of a market for his product.

The Jones-White Merchant Marine Act provides steamship companies with an incentive to construct fast passenger ships, and a splendid fleet of such vessels is now under construction, with others being planned. With one or two exceptions, these vessels are to be steam-driven. But the Jones-White Act does not provide an incentive to construct fast cargo ships such as this country needs for its overseas trade. If and when a law is enacted that will provide assistance for the cargo vessel proportionately as great as that now provided for passenger vessels coming within the scope of the act, a fleet of cargo vessels will come into being and the diesel builder will have an opportunity to demonstrate the worth of his product.

Success in the cargo vessel field means ultimate success in the passenger vessel field. ROSS G. WILLOH.

Norfolk, Va.

The Economic Age Limit

THERE were several answers to the question of an old engineer out of a job, in the May 5 issue, that should interest the old-timers greatly, as we all have been, or some day will be, confronted with the same condition.

I followed metallurgy and mining for twenty years, interspersed with some refrigeration and general operative engineering. I had save little money, but successful investment had increased it so that I had about $10,000 in cash and quick assets, enough to start a small retail business, but not enough to attempt anything large enough to guarantee the income that I had been enjoying. While deliberating, I heard of an opening as a salesman for a machinery firm. I applied and got it.

The successful salesman in mechanical lines is the one who gets out and sees those who possibly might be interested in what he has to sell, and knows his wares so well that he can talk instructively about them. The go-getter type does not flourish in machinery circles. The factory man who can demonstrate by his physical action or his pencil that he has what the consumer needs, seems to be the man who is well-paid and sought-after.

The engineer who turns salesman should have a sufficient command of English to express himself clearly—although I once knew a tongue-tied salesman who did very well—and a willingness to work. With these qualifications, an engineer of experience should at least give selling a tryout.

Another thing, engineers are not affected by the age limit as are many in other lines. Muscular strength is not essential, but knowledge and experience are, and if any reader knows a way of acquiring either without getting a few gray hairs, I should like to make his acquaintance. L. R. BAKER.

Cleveland, Ohio.

Experiences in the Pulverization of Anthracite

Digest of a paper recently presented by H. C. L. Miller, Philadelphia, Pa., resident engineer for Foster-Wheeler Corporation. It gives facts and figures, including maintenance costs on the pulverization of river anthracite at the Middletown station of the Metropolitan Edison Company and the Holtwood steam station of the Pennsylvania Water and Power Company

THE USE of pulverized anthracite in Pennsylvania is increasing, largely as a means of utilizing fine waste. Economically, the problem is one of balancing the admittedly higher preparation cost of anthracite against its lower price.

Various installations have demonstrated that it is commercially possible to prepare and burn anthracite economically in pulverized form. The hardness of anthracite, and the abrasive nature of the pure coal, as well as the impurities associated with it, demand more power, and result in more rapid wear of the grinding and conveying elements. Moreover, the fact that a larger-sized mill is required per ton of anthracite capacity means higher fixed charges on the necessary equipment.

Anthracite is Abrasive and Hard to Grind

Compared with bituminous coal, the grindability factor of anthracite is relatively low. On a scale where the easily pulverized Pocahontas coal is rated 100 (for grindability) anthracite ranges from 30 to 50. The river anthracite, in particular, runs from 30 to 35. Since, then, river anthracite represents the most unfavorable condition of anthracite pulverization, figures concerning its use, presented in this paper, should be of particular interest.

Ball Mills Used

At the Middletown station of the Metropolitan Edison Company and the Holtwood steam station of the Pennsylvania Water & Power Company "silt coal" is dredged from the Susquehanna River. After drying it is pulverized in conical ball mills 10 ft. in diameter and of 66 ft. cylinder length. There is one mill of this size in each of these plants. At Middletown, in addition, is a similar mill 7 ft. in diameter, of 36 in. cylinder length. This was installed with the original equipment for preliminary experimentation with river anthracite.

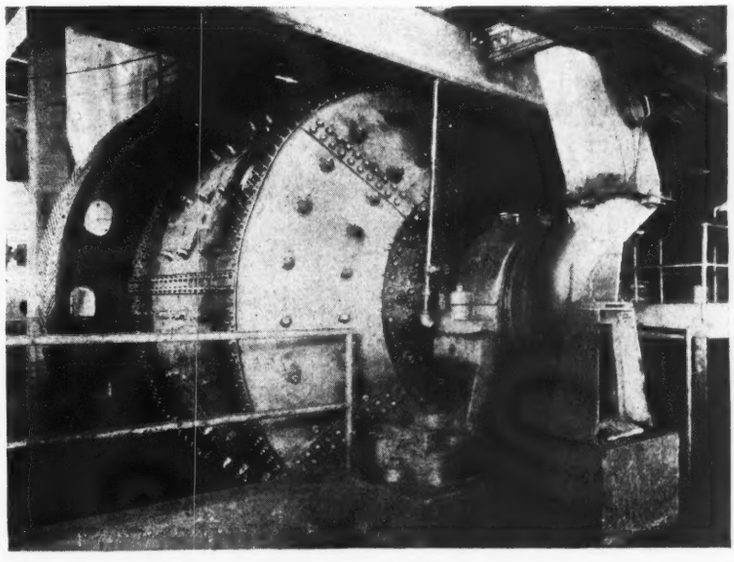
The connections of the 10-ft. mill are shown diagrammatically on the accompanying sketch. The coal-and-air mixture leaving the mill passes through a rotary classifier, and then through a superfine classifier. Fine particles are taken by the circulating air stream from the top of the superfine classifier to the cyclone collector. The pulverized product coming from the collector is conveyed to storage bunkers in the boiler house.

Table I gives pertinent data on the mills at these plants, together with the cost records available.

The tabulation shows, as would be expected, that the relative capacity of the mills on river anthracite is about 50 per cent of their capacity on Eastern bituminous coal. While the figures show a comparison between fine anthracite and Eastern bituminous slack, or crushed run of mine, it should be noted that the river anthracite available is very fine, and that commercial sizes of anthracite would require slightly more power and give slightly reduced capacity.

The fact that the Holtwood installation has operated almost entirely on anthracite, whereas the Middletown mill ground only 35 per cent of this fuel, is reflected in the relative maintenance costs, which are considerably lower at Middletown. In both plants the actual cost of the balls required to maintain the proper charge in the mill was about 70 per cent of the total maintenance cost for labor and material. It will be noted, however, that Holtwood, using a higher percentage of anthracite, used three times as many pounds of balls per ton of coal as Middletown. The remaining maintenance material costs are due to liner and wedge bar, drive pinion and circulating system replacements.

The continuous difficulties encoun-



Ball Mill Installed in Middletown station

TABLE I—COMPARATIVE MAINTENANCE DATA

Mills:	*Middletown*	*Holtwood*
Type	Hardinge	Hardinge
Number	1	1
Size	10 ft.x66 in.	10 ft.x66 in.
Fuel used	River anth. and bituminous	River anth. and bituminous
Started in operation	May 1, 1928	Jan. 23, 1930
Data covers period from	May 1, 1928	Jan. 23, 1930
Data covers period to	Dec. 1, 1930	Jan. 1, 1931
Total Coal Milled (short tons):		
Anthracite	67,006.42	58,091.60
Bituminous	124,678.17	1,564.80
Total	191,684.59	59,656.40
Percentage anthracite	35.0	97.2
Mill Hours:		
Anthracite	6,543.34	5,395.2*
Bituminous	6,129.95	74.4*
Total	12,673.29	5,469.6
Percentage anthracite	51.6	98.5
Mill Rates (short tons per hour):		
Anthracite	10.24	10.80
Bituminous	20.34	21.00
Average	15.10	10.90
Maintenance Data:		
Pounds of balls used per ton	0.397	1.20
Average cost of balls per lb.	$0.0366	$0.0429
Ball cost per ton milled	0.0146	0.0515
Other material cost per ton	0.0031	0.0123
Total material cost per ton milled	0.0177	0.0638
Maintenance labor cost per ton	0.0028	0.0117
Total labor and material cost per ton milled	$0.0205	$0.0755

* Estimated.

Figures include all labor and material to maintain the mills, cyclones, exhausters, feeders, classifiers and interconnecting piping.

TABLE II—ANALYSIS OF MILL OPERATING RECORD FOR 1930

HOLTWOOD STEAM STATION, PENNSYLVANIA WATER & POWER CO.

	March 1, 1930, to Jan. 1 1931	April 1, 1930, to Jan. 1, 1931
Per cent total hours operated	72.4	79.5
Per cent total hours idle	7.6	7.0
Per cent total hours bunkers full	2.9	3.1
Per cent total hours available	82.9	89.6
	Outages in Per Cent of Total Hours	
Mill, motor and feeder	4.29	3.13
Classifiers and collector	6.24	1.15
Mill exhauster	0.14	0.15
Transport pump and filters	1.43	1.60
Inspection	2.25	2.51
Dryer, elevator, screw conveyor and other causes	2.75	1.88
Total outage, per cent	17.10	10.42

tered in the preparation of anthracite arise from its highly abrasive character, and from its high density. The latter may lead to settling out in the mill-return pipes and the classifiers. For this reason pipe and separator sizes must be carefully studied, particularly where the same system must handle either anthracite or bituminous coal.

Pulverized Anthracite Burned Without Difficulty

Other than greater wear on the various parts of the conveying and heating apparatus, no particular difficulties have been experienced in the burning of silt coal under the boilers. The total demand for fuel at Middletown is greater than can be met with the available supply of river coal alone. It is therefore mixed in the bunkers and the heating system with bituminous.

The resulting product going to the burners has a higher average volatile content and is easier to ignite than if anthracite alone were used. At this plant it has been found that the river coal should be pulverized 78 to 84 per cent through 200 mesh for proper results, whereas the bituminous coal used averages 75 per cent through 200 mesh.

At Holtwood, in the same type of furnace, river coal has been burned alone. The average fineness runs from 75 to 80 per cent through 200 mesh, and a cold furnace can be lighted in 5 to 10 min. by using portable oil-burning torches. Because of the tendency toward longer flame travel, reportioning of the quantities of secondary air admitted at the different ports in the front wall is necessary when burning anthracite.

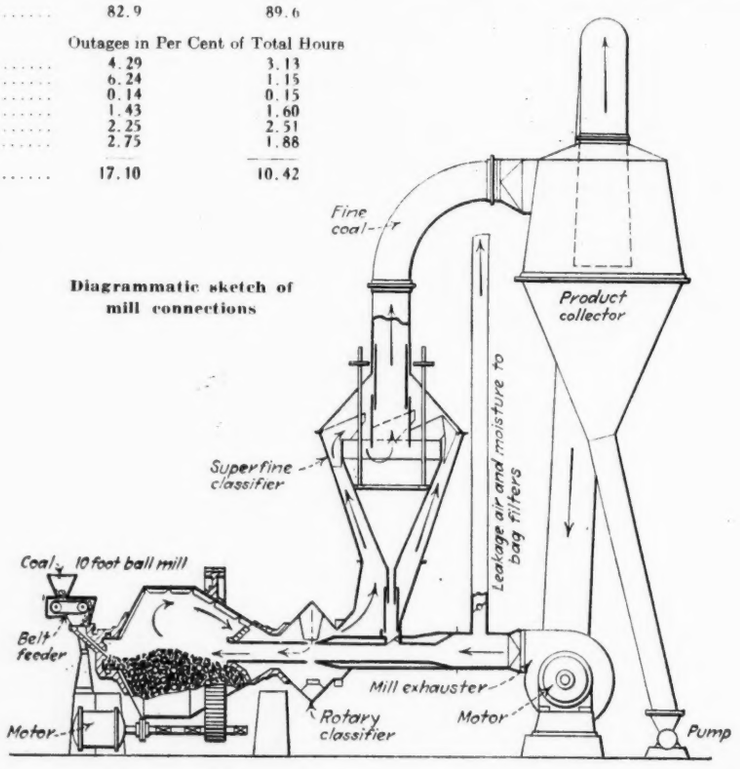
The total preparation cost at Holtwood, for the year of 1930, exclusive of fixed charges, was 24.7c. per net ton of river coal prepared. This figure includes all mill house power, labor and supplies, and covers the conveying, drying and transport systems, in addition to the milling system itself.

An Enlarged Opportunity for Anthracite

If the average ash content in the silt coal—18 to 20 per cent—were reduced by washing and classifying the fuel at the mine, the preparation cost would probably be reduced below the Holtwood figure, which means that it would be able to compete with bituminous coal at greater distances from the mine, or would produce steam at a cheaper price if pulverized and burned near the point of production.

With low preparation cost it is believed that any of the steam sizes now marketed can be used for steam generation at a lower over-all cost than is now being obtained on chain grates.

While many of the difficulties in anthracite pulverization have been successfully overcome, there are still more to be met. Although a new plant designed for the use of anthracite can prepare bituminous, also, in sufficient quantity to maintain its load, a continuous supply of anthracite should be reasonably assured in order to justify the fixed charges on the additional milling and other preparation costs attendant on its use.



Diagrammatic sketch of mill connections

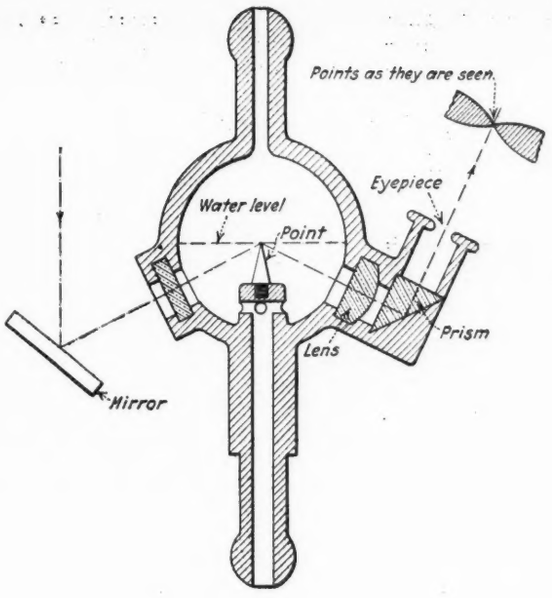


Fig. 1—Contact of the point with the water is observed from beneath the water surface, using the principle of total reflection

A Precision Water Level and Pressure Gage

A PRECISION water-level gage, accurate to within 1/2500 part of an inch, was described in the Feb. 27 number of *The Engineer* (London). The following comments, with accompanying illustrations, are based on those in *The Engineer*.

Aside from a micrometer type of stand, the essential part of the instrument is the observing chamber shown diagrammatically in Fig. 1. By means of mirrors and lenses the contact point and its reflection in the water surface is observed from below, using the principle of total reflection. Adjustment of the point to the exact water surface is made by shifting the micrometer or the water level until the metal point exactly touches its reflection. The chamber is connected to the water tank by an ordinary rubber tube.

The obvious use of this equipment is to make direct measurement of water level in tanks, over weirs, etc., where extreme precision is required. There are, however, many other uses. The gage has already been used to measure pressures in gas mains, air flow in wind channels, and fan pressures. It can be used to measure the daily and hourly evaporation from large water surfaces such as lakes.

An interesting application suggested in *The Engineer* is its use to level up shafting and foundations. By connecting the rubber pipe to a small portable cistern mounted on a tripod or V-block such leveling may be effected with great precision.

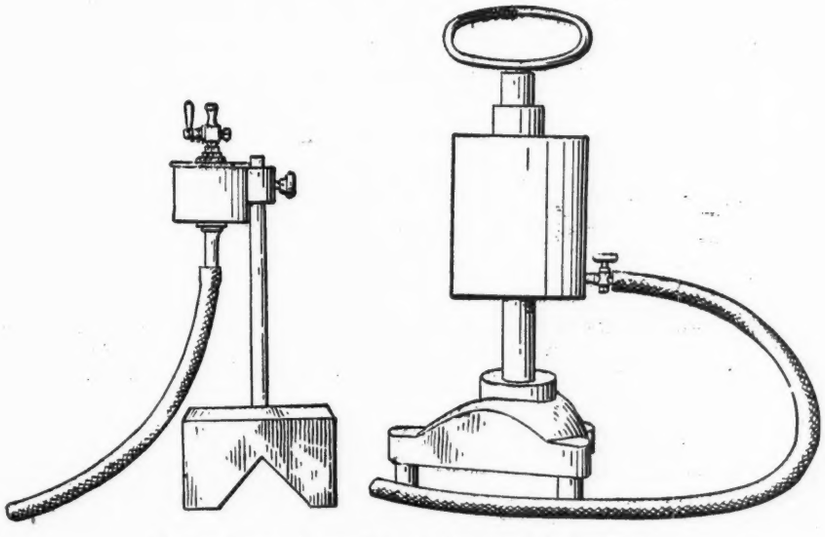


Fig. 2—Types of movable cisterns used in leveling shafting and foundations

Progress Reported on Canadian Hydro Projects

A PROGRESS REPORT issued by the Northwestern Power Company, subsidiary of the Winnipeg Electric Company, states that the schedule of work on the large power development at Seven Sisters Falls, on the Winnipeg River, is being closely maintained. Installation of turbines, mechanical and electrical equipment, as well as the construction of the transmission line between Seven Sisters Falls and Winnipeg, is now in progress. It is anticipated that the first unit will be in operation this summer.

Construction work was started early last year. Since then the heavy construction work for the initial development, consisting of power house substructures and superstructure for the installation of the first three units, dams and initial dykes, has been practically completed. The substructure for the remaining three units has been constructed to a point where unwatering expense will be at a minimum for the installation of the additional turbines and generators as required.

MACLAREN-QUEBEC POWER COMPANY'S development at Masson Falls on the Lievre River in Quebec, is proceeding according to schedule and the present working force of about 400 men will be augmented considerably upon completion of preliminary operations. Since the general contract was awarded in February, cofferdams have been built, the foundations for one-half of the large diversion dam above the falls laid, and a central shaft, to be used as an outlet for rock and other débris from the diversion tunnel, has been sunk to a depth of 150 ft. The diversion dam and tunnel will enable most of the 185-ft. fall of the river at Masson to be utilized, and will take a year or longer to complete. The 25-ft. pressure tunnel, to be cut through solid rock some 200 ft. below the surface of the ground and lined with concrete, will be approximately one mile long and at its downstream end will be divided into two smaller tunnels, to each of which two penstocks and a large tank will be connected. Twelve gates, each 14 ft. wide and 18 ft. 6 in. high, will control the waters at the tunnel intake.

The power plant will have an installed capacity of 130,000 hp. when completed, and of this total, 125,000 hp. will be delivered under a long-term contract, to the Ontario Hydro Electric Power Commission.

WORK ON THE construction of the Rapide Blanc development on the Upper St. Maurice River, in the province of Quebec, which the Shawinigan Water & Power Company started last year, has advanced beyond the preliminary stage and owing to the very satisfactory termination of the cofferdam building which was carried on during the winter, the permanent works are under construction at the present time.

From Among Readers' Problems

Conducted by
L. H. MORRISON

PHASING-OUT ALTERNATORS—*Can the phasing out of two three-phase alternators, to be operated in parallel, be done by using a three-phase induction motor and connecting it to one machine and then to the other?* R.S.

Phasing-out of two three-phase alternators can be done by an induction motor. The motor should be connected to the busbars or to one of the feeders supplied from them. Assume two alternators, Nos. 1 and 2, and No. 2 to be phased out with No. 1. First connect No. 1 to the busbars by closing its switch, and note the direction in which the motor rotates. Open the switch of No. 1 machine and close the switch for No. 2 machine and again note the direction in which the motor runs.

If the two machines have the same phase relation the induction motor will run in the same direction on either machine. When No. 2 machine is connected to the busbars, if the motor runs in the direction opposite to that when No. 1 unit is supplying the power, it shows that the phase rotation of No. 2 is opposite to that of No. 1. To correct the phase rotation of No. 2 machine interchange any two of three generator leads at the switch or at the machine. After the leads have been changed the machine should again be connected to the motor and the phase rotation checked. When correct phase relation has been established between the two alternators they may be synchronized and connected in parallel.

Before synchronizing the machine for the first time the synchroscope must be checked. This may be done by connecting two transformers and lamps to the generator's switch so as to synchronize the machine with the lamp dark. Start up the machine and when the lamps are dark the pointer on the synchroscope should point to synchronism, if it is connected correctly.

BURNING IOWA COAL—*We are contemplating burning Iowa coal, which is cheaper than Illinois coal. Will the coal burn satisfactorily when pulverized?* E.M.

The Experimental Station at Iowa State College made a study of this problem and reached the following conclusions:

On the basis of actual operation, Iowa coals, when burned in pulverized form, may be depended upon for efficient and reliable generation of heat and power. The conditions of operation, the maintenance of the necessary pulverizing equipment, the maintenance of the furnace, and the regulations for varying loads are no more difficult than when using other coals in pulverized form.

Some large plants are using Iowa coal in pulverized form very satisfactorily from both a mechanical and an economical standpoint.

Some small plants may be changed over at a reasonable cost for reconstruction and the necessary pulverizing equipment, and then be equipped for burning most of the Iowa coals efficiently.

In medium and small sized plants reliable mechanical operation and high thermal efficiency is attained by using the coal in pulverized form.

Starting and stand-by losses are reduced to a lower figure when using pulverized coal than when using other forms of firing.

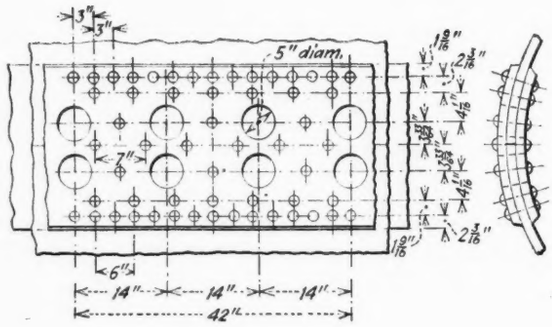
The actual economy of burning Iowa coal in pulverized form depends upon the price of the coal delivered. The comparative price should be based on the heat-unit value of the coal and the ash and moisture contents.

Iowa coals in pulverized form are being used successfully in power plants, heating plants, cement mills, brick and tile plants, metallurgical furnaces, and ceramic kilns. Each application has presented its special problems and conditions.

If one expects to use Iowa coals under exactly the same conditions, and with the same adjustments as when using other coals, disappointment may be the result. All coals require more or less special attention to some detail of equipment and regulation.

PREVIOUS QUESTIONS DISCUSSED BY READERS

1. *WHAT working pressure can be carried on the 48-in. drum whose seam is shown in the illustration? The 5-in. openings are for the tubes. The specifications are as follows: Material, firebox 55,000-lb. steel; plate thickness $1\frac{1}{16}$-in.; outer strap $\frac{3}{4}$-in.; inner strap $\frac{3}{4}$-in.; rivet holes $1\frac{1}{32}$-in.* W.G.D.



FROM the sketch one can very readily see that 42 in. and not 14 in. is the unit pitch that should be used in figuring the joint efficiency.

The middle row of rivets are tack rivets and do not enter into our calculation, as they do not help to strengthen the joint.

The strength of solid plate $= 42 \times 1.0625 \times 55{,}000 = 2{,}454{,}375$ lb.

Strength of plate between rivet holes in outer row $= [42 - (14 \times 1\frac{1}{32})] \times 1\frac{1}{16} \times 55{,}000 = 1{,}610{,}686$ lb.

The strength of plate between rivet holes in the second row, plus the shearing strength of 14 rivets in double shear $= [42 - (7 \times 1\frac{1}{32})] \times 1\frac{1}{16} \times 55{,}000 + (14 \times 0.8352 \times 88{,}000) = 3{,}061{,}557$ lb.

The shear of all rivets in double shear $= 24 \times 0.8352 \times 88{,}000 = 1{,}763{,}942$ lb.

The strength of plate and butt strap between the second row of rivets $= [42 - (7 \times 1\frac{1}{32})] \times (\frac{3}{4} + \frac{3}{4} + 1\frac{1}{16}) \times 55{,}000 = 4{,}901{,}982$.

Strength of the plate between rivet holes in the second row, plus the crushing strength of butt strap in front of 14 rivets in the outer row $= [42 - (7 \times 1\frac{1}{32})] \times 1\frac{1}{16} \times 55{,}000 + (1\frac{1}{32} \times 2 \times \frac{3}{4} \times 95{,}000 \times 14) = 4{,}089{,}871$ lb.

Strength of the ligament between the tube and rivet holes $= [42 - (3 \times 5) - (3 \times 1\frac{1}{32})] \times (\frac{3}{4} + \frac{3}{4} + 1\frac{1}{16}) \times 55{,}000 = 3{,}369{,}287$ lb.

Strength of the plate ligament be-

tween tube holes and rivet holes plus 21 rivets in double shear $= [42 - (3 \times 5) - (3 \times 1\frac{3}{32})] \times 1\frac{1}{16} \times 55{,}000 + (21 \times 0.8352 \times 88{,}000) = 2{,}940{,}470$ lb.

Strength of plate ligament between tube holes, plus crushing strength of butt straps in front of 21 rivets $= [42 - (3 \times 5) - (3 \times 1\frac{3}{32})] \times 1\frac{1}{16} \times 55{,}000 + (2 \times \frac{3}{4} \times 1\frac{3}{32} \times 21 \times 95{,}000) = 4{,}483{,}036$ lb.

From these calculations we find that the weakest part of the joint is the tear of the plate in the outer row of rivets. So we divide this quantity by the strength of the solid plate, which gives the efficiency $\frac{1{,}610{,}686}{2{,}454{,}375} = 0.65625$, or 65.625 per cent.

The formula for the working pressure is $WP = \frac{TS \times t \times E}{R \times FS}$

where TS = Tensile Strength = 55,000 lb.
t = Thickness of plate = $1\frac{1}{16}$ in.
E = Joint efficiency = 65.625 per cent.
R = Radius of drum = 24 in.
FS = Factor of safety = 5.

Substituting

$$WP = \frac{55{,}000 \times 1\frac{1}{16} \times 0.65625}{24 \times 5} = 316 + \text{lb.}$$

JAMES M. LYLE,
Henry Vogt Mach. Co.
Louisville, Ky.

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THE ITEM to be given first consideration when analyzing the seam, or reinforced section, is the strength of a unit section of the unpierced shell plate. If the spacing of the rivet holes and tube holes is uniform, the unit section may be considered as having a length equal to a rivet-hole pitch, or a tube-hole pitch, as the case may be. But where the spacing of the rivet holes and tube holes is not uniform, the unit section should be taken as one inch in length.

Accordingly, the calculation used in determining the strength of the unpierced sheet becomes:

$$\frac{t \times Ts \times 1}{1} \text{ or } \frac{1.0625 \times 55{,}000 \times 1}{1} = 58{,}437 \text{ lb.} \quad (1)$$

Likewise, with a trifle more complication, we find the strength of the shell plate along the centerline of the rivets having a 3-in. pitch as follows:

$$\frac{t \times Ts \times (P - d)}{P} \text{ or } \frac{1.0625 \times 55{,}000 \times (3 - 1.03125)}{3} = 38{,}339 \text{ lb.} \quad (2)$$

per inch of length.

The shell plate might fail along the centerline of rivets' pitched 6-in. centers, but to do so the rivets having 3-in. pitch would have to shear at both the inner and outer reinforcing straps, so are in double shear. There are two of those rivets for each rivet in the 6-in. pitch line. The calculation becomes:

$$\frac{t \times Ts \times (P - d) + SS \times N}{P} \text{ or } \frac{1.0625 \times 55{,}000 \times (6 - 1.03125) + (75{,}680 \times 2)}{6} = 73{,}632 \text{ lb.} \quad (3)$$

The plate along the centerline of 5_{32}-in. tube holes pitched 14 in. apart is further weakened by the $1\frac{3}{32}$-in. rivet holes. The shell plate might fail by cracking through those openings, but such failure would also involve the shearing of the rivets in the row having 3-in. pitch and in the row having 6-in. pitch. The strength of the shell plate tube ligament plus the strength of the rivets in shear is found as follows:

$$\frac{t \times Ts\,[P - (D + d)]}{P} + \frac{SS \times N}{P} \text{ or } \frac{1.0625 \times 55{,}000\,[14 - (5 + 1.03125)]}{14} + \frac{75{,}680 \times 3}{6} = 74{,}754 \text{ lb.} \quad (4)$$

A possible method of failure which must be considered in some cases, although not necessary in this case, is the shearing of all rivets. The strength of those items would be calculated as follows:

$$\frac{SS \times N}{P} \text{ or } \frac{75{,}680 \times 3}{6} + \frac{75{,}680 \times 1}{14} = 43{,}243 \text{ lb.} \quad (5)$$

The shell plate has a thickness of 1.0625 in., while the combined thickness of the inner and outer butt straps is 1.5 in., so the butt straps are proportionately stronger than the shell plate and it is not necessary to calculate their strength.

As the strength of the shell plate between the rivet holes as determined by equation No. 2 is less than the value found for any other method of failure, the relation of the strength of the seam as compared to the unpierced plate is found by dividing the result of equation No. 2 by the result of equation No. 1, which gives approximately 65 per cent as the efficiency of the seam.

$$\frac{38{,}359}{58{,}437} = 0.656, \text{ or } 65.6 \text{ per cent.} \quad (6)$$

By using that efficiency in the standard formula, we find that the safe working pressure is 7,677 divided by the radius, or

$$\frac{t \times Ts \times \%}{R \times Fs} = WP, \text{ or } \frac{1.0625 \times 55{,}000 \times .656}{R \times 5} = \frac{7{,}677}{R} = WP \quad (7)$$

If the drum diameter is 48 in., the working pressure will be:

$$\frac{7{,}677}{24} = 319 \text{ lb.} \quad (8)$$

A limiting factor which does not affect the design under consideration but which is frequently overlooked or misunderstood justifies its mention here. The spacing of the rivets and tubes in a reinforcing tube section is referred to in A.S.M.E. Code, P-193, which applies the formula in P-199, using 135 as the constant C. The pitch of rivets and tubes is based upon the pressure that can be carried safely by the inner plate.

A shell plate 48 in. in diameter, of $\frac{3}{4}$-in. steel and seamless, would have a safe working pressure of 344 lb., determined as follows:

$$\frac{t \times Ts}{R \times 5} = \frac{0.75 \times 55{,}000}{24 \times 5} = 344 \text{ lb.} \quad (9)$$

The maximum pitch of staybolts or rivets used in a stayed flat surface $\frac{3}{4}$ in. thick, carrying a pressure of 344 lb., is determined by the formula in P-199 to be $7\frac{1}{2}$ in., as follows:

$$P = c\frac{T^2}{p^2}$$

Where T is the plate thickness in sixteenths of an inch and p is the pitch.

$$344 = \frac{135 \times (12)^2}{p^2} \quad (10)$$

$$p = 7.5 \text{ in.}$$

Accordingly, the maximum distance between tube centers and rivet centers in the problem under discussion is within code limits.

The minimum "back pitch," or distance between the centerlines of adjacent rows of rivets, is found by the formula in P-183 of the code and formula b would apply.

$$2d + 0.1\,(P - 4d) \text{ or } (2 \times 1.03125) + \frac{6 - (4 \times 1.0325)}{10} = 2.25 \text{ in.} \quad (11)$$

The sketch illustrating the tube sheet ligament reinforcement gives the distance between the rivets in the first and second rows as $2\frac{3}{16}$ in., instead of the required $2\frac{1}{4}$ in. The difference is slight, but sufficient to cause the rejection of the boiler if intended to meet A.S.M.E. code requirements.

M. P. JARED.
New York City.

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THE RIVETS on the center line *a* have no value other than holding the plates together. The rivets between the tube holes longitudinally have a shearing value and must be considered. This is a 14-in. spacing, whereas we have a 3- and 6-in. spacing in the outer two rows and we must find a unit section of this seam on which to base our calculations. The least common multiple of 3, 6 and 14 is 42-in., and will be used as the unit section.

The shell plate value $= 42 \times 1.0625 \times 55{,}000 = 2{,}454{,}375$ lb.

The value of the plate left between rivet holes in the other row of rivets $= (42 - 14 \times 1.03125) \times 1.0625 \times 55{,}000 = 1{,}610{,}682$ lb.

Shearing value of 24 rivets in double shear $= 0.8325 \times 24 \times 88{,}000 = 1{,}758{,}240$ lb.

The crushing of the plate in front of the 24 rivets $= 24 \times 1.03125 \times 1.0625 \times 95{,}000 = 2{,}498{,}186$ lb.

The weakest point, then, is through the outer row of rivet holes, giving the

efficiency of the riveted seam

$$\frac{1,610,625}{2,454,375} = 65.6 \text{ per cent.}$$

We must now consider the value of both butt straps through the tube opening line. This is calculated on a unit section of 14-in. The plate area for a distance of 14 inches $= 14 \times 1.0625 = 14.875$. This represents 100 per cent of the metal.

The area of both butt straps $= (2 \times 0.75 \times 14) - 2 \times 0.75\ (5 + 1.03125) = 11.954$, and the efficiency of the straps becomes $\frac{11.954}{14.875} = 80.3$ per cent.

The working pressure on a 48-in. diameter drum with a seam of this design, which has an efficiency of 65.6 per cent would be

$$\frac{1.0625 \times 55,000 \times 65.6}{24 \times 5} = 319 \text{ lb.}$$

G. M. LORENZ,
Boiler Inspector.

Barberton, Ohio.

[The two answers above are by inspectors of the same boiler insurance company, and the difference in the calculated pressures shows that experts other than doctors will sometimes disagree.—Editor.]

2. *WHAT IS THE relation of the air ejector capacity to the capacity of the condenser? For example, should the ejector of a 10,000-kw. condenser be twice as large as one on a 5,000-kw. unit?*

A.G.C.

AS THE condenser of a 10,000-kw. turbine will not have twice as many points of air in-leakage as the condenser of a 5,000-kw. turbine, it is reasonable to assume that the air ejector capacity would not need to be twice as large.

Very little air enters with the steam, especially in modern plants. The air is eliminated from the feed water before it goes to the boiler. Nearly all the air that gets in the condenser, does so through porous castings, leaky joints or leaking shaft or gland seals. Air leakage is practically independent of the vacuum so long as the vacuum is over 18 in. of mercury.

A prominent manufacturer of condensers has published a curve indicating the size or capacity of an air ejector that should be used when the pounds of steam to be condensed per hour is known. The capacity of the air ejectors is based on the cubic feet of atmospheric air handled per minute on orifice test. Some of the figures taken from the curve are: For 50,000 lb. of steam per hour the air ejector has a capacity of 9 cu.ft. per minute; for 100,000 lb. of steam the capacity is 15 cu.ft.; for 200,000 lb. of steam the capacity is 24 cu.ft.; and for 300,000 lb. the capacity is 32 cu.ft. It will be noted that for an increase of 100 per cent in the capacity of the condenser the capacity of the air ejector increases approximately 60 per cent.

A 5,000-kw. turbine would exhaust about 65,000 lb. of steam per hour to be condensed and the air ejector capacity should be 11 or 12 cu.ft. A 10,000-kw. turbine would exhaust about 125,000 lb., and the air ejector capacity should be 17 or 18 cubic feet. GEORGE DREYER.

Detroit, Mich.

AIR REMOVED from a condenser is made up of the air entrained in the boiler-feed water and carried through the system with the steam, and that which enters through leaks in the part of the system under vacuum. The air entrainment in the boiler-feed water may be reduced to a small amount by the use of open feed-water heaters and deäerators. The air entering the system as a result of leakage depends on the size of the condenser and the tightness of joints and packings.

The capacity of an air ejector for a condenser is based upon experience rather than theory, and the various factors entering into the installation would have to be considered to make a definite recommendation.

Experiments have been made on various installations and curves drawn up which show the amount of air to be removed from surface condensers for various quantities of steam condensed. These curves give the amount of dry air to be removed, but since this air is saturated with water vapor, the total weight of the mixture of air and water vapor to be removed may be obtained from curves using the proper values for temperature and vacuum.

For example, the curves show that for a surface condenser condensing 200,000 lb. steam per hour the dry air to be removed from the condenser will be 46 lb. per hour, while with one condensing 100,000 lb., 29 lb. of dry air per hour must be removed. These capacities are based on tight systems and good operating conditions, and should not be used blindly, without due consideration to actual conditions, for any particular installation. W. B. FRAZER.

Montreal, Que.

THE SIZE of an air ejector for condenser service varies considerably for different installations, because air infiltration into the condenser and the air content of the steam are varying quantities. Size or capacity, therefore, is based on previous performance rather than on theory.

High vacuum in a condenser would cause more infiltration; hence, size depends on the operating vacuum for which the turbine is designed. The quantity of air dissolved in the feed water decreases with an increase in temperature. Hence, turbines operating on steam from a high temperature feedwater supply will require smaller ejectors than those supplied from a cold-water source.

An article by F. R. Wheeler "Air Pumps for Condensing Equipment" in *Mechanical Engineering*, December, 1919, gives a set of curves for determining air ejector size. Usually, two ejectors are used, each of the capacity determined by curves, as results so obtained give minimum capacity requirements.

The table given below shows the cubic feet per minute capacity of several recent installations. Sizes vary over a wide range, but tend to show that higher-vacuum turbines require higher capacity ejectors.

Turbine Size	Vacuum, In. of Mercury		
Kw.	28	29	29.5
5,000	20	..	....
25,000	30	..	39
30,000	21	..	150
37,000	22	30	....
60,000	40	63	....

From the above statements it can be seen that air ejector capacities vary over a wide range, since they depend on several factors. However, whether a 10,000-kw. turbine would require an ejector capacity of $1\frac{1}{2}$, 2 or even 3 times as much as a 5,000-kw. unit would depend entirely on operating conditions.

GORDON R. HAHN.

Astoria, L. I.

A Question for Our Readers

WITHDRAWAL of water from a tank placed in the suction line of a centrifugal pump is to provide sufficient vacuum when the pump starts to fill the empty suction line and to supply the requirements of the pump in the meantime.

At the outset the suction line will be full of air at atmospheric pressure and the pump will deliver 500 g.p.m., which will diminish continuously for two minutes to 300 g.p.m. The suction line consists of 25 ft. of 5-in. pipe, with 3 ells, and the highest static lift is 15 ft. Cold water will be used.

Assuming the tank full of water to begin with, what must be its minimum capacity? What would be the size if the tank contained only 90 per cent water? T.A.

Suitable answers from readers will be paid for[1] and published in the June 23 number

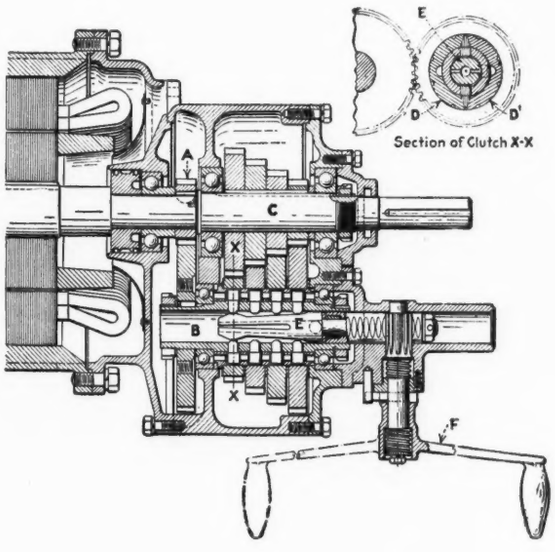
[1]As an alternative to cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired)

Morrison's *American Diesel Engines;* Walker and Crocker's *Piping Handbook;* Norris and Therkeisen's *Heat Power;* Emswiler's *Thermodynamics;* Church's *Steam Turbines;* Uehlings' *Heat Loss Analysis;* Croft's *Steam Power Plant Auxiliaries and Accessories;* Powell's *Boiler Feed Water Purification;* Osborne's *Power Plant Lubrication;* Moyer and Fritz' *Refrigeration;* Rietschel - Brabee's *Heating and Ventilation;* Annett's *Electric Elevators.*

WHAT'S NEW IN PLANT EQUIPMENT

Combination Multi-Speed Drive and Motor

A MULTI-SPEED reduction gear unit built in combination with a standard alternating-current motor has been developed by Roy T. Wise, consulting engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. It is designated the Westinghouse-Wise multi-speed drive. Constructed to give four different speeds to the output shaft at constant horsepower, the unit is applicable to a rather wide range of industrial operations which require drives providing more than one speed. With this drive the speed of the driven apparatus may be changed instantly while the motor is running at full speed and under full load.

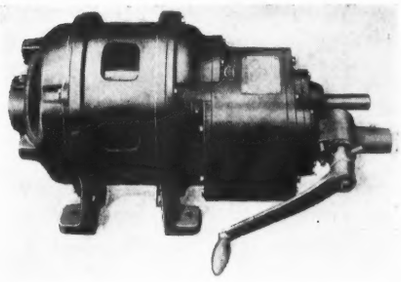


Cross-section of drive showing details of construction. Speed changes can be made while motor is running at full speed and under full load

The gear unit is mounted on a standard squirrel-cage Westinghouse induction motor. A pinion *A* mounted on the motor shaft drives a gear mounted on a hollow countershaft *B*. Also on the countershaft are four idling ring gears which are constantly in mesh with four gears that are pressed on the output shaft *C*. Each of the countershaft gears is provided with an internal clutch as shown in detail in the section *X-X*. The clutch is actuated by two tapered wedges which are forced between the clutch halves *D* and *D'* by a spring member *E*. To bring this member to the correct position for a desired speed, the control handle *F* is rotated, actuating a rack mounted on the spring member *E*. This movement brings the spring member between the tapered wedges, thereby providing the pressure for clutching any one of the four ring gears to the counter shaft, which in turn drives the output shaft at the desired speed.

Between each speed is a neutral position. To disengage the clutch and bring it into a neutral position, it is only necessary to rotate the handle to draw the spring member into a position which does not contact the expanding wedges. A further movement of the handle brings the spring member into contact with the next set of expanding wedges, and clutches the next gear to the countershaft. Therefore, it is not only possible to make speed changes under full load, but the apparatus can be stopped or started under that condition.

Ball bearings are used in both motor and gear unit. The gearing in the first reduction, or drive from the motor to the countershaft, is of the single helical type and the other gears on the countershaft and those on the output shaft are of the spur type. A simple but positive splash system is provided for lubricating both the gearing and the bearings. Oil is picked up by the gear teeth in the lower part of the case and delivered to mating gears and all other moving parts. An oil gage is provided for checking the oil level.

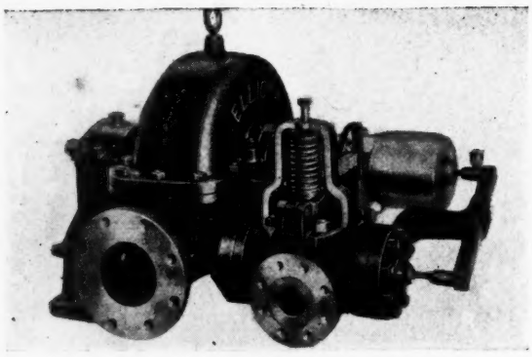


Westinghouse-Wise multi-speed drive mounted on induction motor

The multi-speed drive is offered in three units, ranging in rating from $\frac{1}{2}$ to $7\frac{1}{2}$ hp. The four speeds available in the gear drive itself, plus the availability of motors giving different driving speeds, make is possible to choose a combination that covers a wide range of speeds.

New Steel Permits Hand Bending of Rigid Conduit

RIGID CONDUIT the smaller sizes of which can be bent across the knee without tools is a recent improvement in wiring construction materials announced by the merchandise department of the General Electric Company, Bridgeport, Conn. The new conduit is said to cut and thread more easily, giving a clean-cut, firm-holding thread. The easy-bending quality is the result of the development of a new kind of flexible alloy steel, now used in all G. E. rigid conduit in the sizes that are adapted to hand-bending.



Type AY turbine built in sizes from 5 to 60 hp., is suitable for operation with 400-lb. steam and 700 deg. temperature

Mechanical Drive Turbine

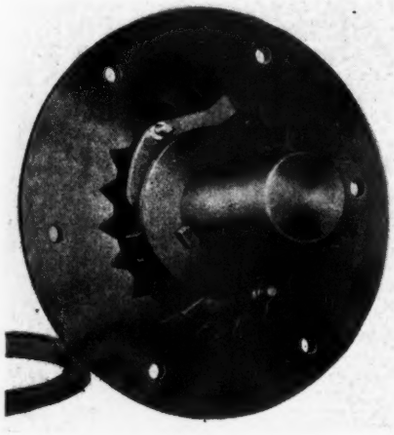
INCORPORATING in its design many features of the larger turbines for generator drive, the Type AY mechanical-drive turbine recently announced by the Elliott Company, Jeannette, Pa., is made in a range of sizes from 5 to 60 hp. It is a single-stage unit, the rotor having either two or three bucket wheels, depending upon conditions. When lagged and built with cast-steel casing and steam chest, the unit is suitable for operation with 400-lb. steam and 700-deg. temperature.

Among the features incorporated in the design are horizontally split casing, steam and exhaust connection in lower half of casing, stiff rotor shaft, a three-weight governor, emergency overspeed governor separate from speed governor, each governor actuating its own valve, and supports providing for the axial and lateral expansion.

Backstop for Preventing Shaft Reversal

THE construction of the Landahl life-time backstop is such that it serves not only as a positive means of preventing shaft reversal, but also as a bearing. It eliminates shaft end thrust in either direction, so that no separate set collars are required. Its internal construction consists of two locking pawls mounted on pins held by two floating rings and a pawl collar.

All of these parts rotate as a unit by engagement of the pawls with the pawl collar. This pawl collar is shaped so that the pawls do not engage the ratchet as long as the shaft is traveling in the correct direction, but lock in the ratchet immediately the shaft direction reverses. The pawl collar is rigidly fastened to the shaft both by a key and a set-screw. The floating rings are seated in the ratchet housing, but are free to rotate with the pawls and pawl collar. The pawls engage and disengage without rubbing the ratchet, and all working parts rotate in an oil bath. The backstops, which are put out by the Fairfield Engineering Company, Marion, Ohio, are available in two styles, as illustrated, and type B with pedestal bearing.



Landahl backstop

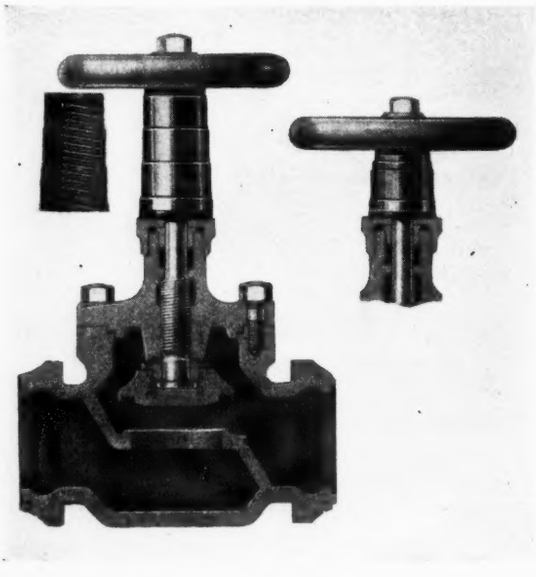
Valve Stem Protecting and Lubricating Shield

ALTHOUGH developed primarily for use in the refrigerating field and used for some years in that industry, the line of valve stem lubricating shields put out by the York Ice Corporation, York, Pa., is now being adapted to the various types of valves used in the power plant and other industries.

The shield is designed to protect the valve stem from dust and grit, and to lubricate it effectively, thus increasing the life of the packing and insuring an easily operated valve.

In the acompanying illustration the shield is shown in place, with the valve open and shield extended and with the valve closed and shield compressed. Furnished in brass or aluminum, it is made up of three, four, five or six sections, resembling somewhat a collapsible metal drinking cup. The sections are held in place by an internal spiral spring, as shown in the sectional view, which allows the shield to follow the opening and closing of the valve and at the same time hold it securely against the sealing washer at each end.

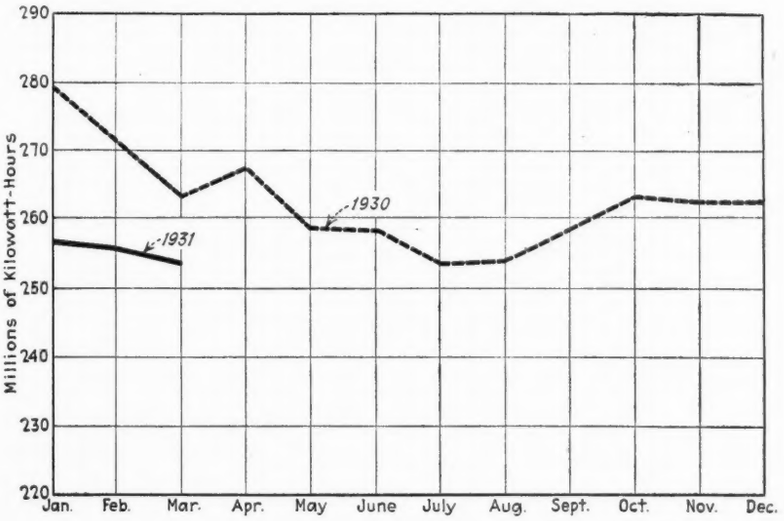
In putting the shield in position it is packed partially full of a suitable grease and placed on the stem with a felt washer top and bottom. A small hole is provided in the next to the top section to act as a relief for excess grease, should it be filled too full, and to permit the adding of a little oil from time to time when necessary to liven up the grease. The shield is available in valve stem sizes ranging from $\frac{3}{8}$ to $1\frac{1}{2}$ in. and in a variety of lengths.



View of shield in extended and compressed position on ammonia valve. It is designed to protect the valve stem from dust and grit, and to effectively lubricate it

NEWS of the FIELD

Public Utility Power Production Drops 6 Per Cent in First Quarter of 1931



Average daily production of public utility power plants

ELECTRIC POWER production of public utility power plants in the United States during the first three months of this year totaled 22,965,000,000 kw.-hr., as compared with 24,477,000,000 kw.-hr. produced in the corresponding period of 1930, according to figures just released by the Geological Survey of the Department of the Interior. This amounts to a decrease of 6 per cent from last year's production and a drop of 3 per cent under the production level of the same period in 1929.

As shown by the chart, average daily production of electricity by public-utility plants in March, 1931, was 253,600,000 kw.-hr., 0.8 per cent less than the daily production for February and 1 per cent less than the daily output for January. In 1930 the average daily production for March was about 5 per cent less than in January of the same year. The normal decrease in daily output from February to March is about 2 per cent, it is stated by the Geological Survey.

Average daily production of electricity by the use of water power in March of this year was about 9 per cent larger than in February. The normal increase is said to be about 7 per cent. During the first quarter of 1931 hydro-electric power amounted to 31 per cent of the total output, as compared with 37 per cent for the corresponding period last year. The Geological Survey reports that precipitation throughout the nonarid portion of the country was less than normal during the first three months of this year, and hydro-electric plants have suffered from lack of water.

Power production figures of the Geological Survey are based on the operation of all power plants producing 10,000 kw.-hr. or more per month, engaged in generating electricity for public use, including central stations, both commercial and municipal, electric railway plants, plants operated by steam railroads generating electricity for traction, Bureau of Reclamation plants, public works plants and that part of the output of manufacturing plants which is sold for public use.

Seattle Council Approves Successor to J. D. Ross

DESPITE the resolution passed in March, following the dismissal of J. D. Ross as superintendent of the Seattle municipal light department, that it would confirm no other appointee to the position than Mr. Ross, the City Council confirmed the appointment of W. Chester Morse on May 4 by a vote of 5 to 4. Major Morse, second appointee of Mayor Frank Edwards, had previously been rejected by the Council by a vote of 6 to 3. The favorable vote on May 4, therefore, came as a complete surprise to supporters of Mr. Ross, who were still working for his reappointment.

Mayor Edwards had named seven men to fill the superintendent's position before one was found acceptable by a majority of the Council. During that time a petition to recall the Mayor was circulated, and it is reported that enough signatures have been obtained on the petition to insure its being placed before the voters.

Governor Roosevelt Names Power Authority Trustees

AS HE LEFT for France on May 6, Governor Roosevelt announced the appointment of the five trustees of the New York Power Authority, created by the Legislature to work out a plan for developing the water-power and navigation facilities of the St. Lawrence River. The appointees are as follows:

Frank P. Walsh, New York City lawyer and public utility expert; Professor James C. Bonbright, of the School of Business at Columbia University and a specialist on utility evaluation; Fred Freestone, master of the New York State Grange; Morris L. Cooke, consulting engineer of Philadelphia who has acted as advisor to Governor Pinchot in the recent investigation of public utilities in Pennsylvania; and Delos Cosgrove, a lawyer of Watertown, N. Y., whose practice has put him in contact with water-power problems.

The five trustees of the Power Authority are recess appointees, subject to confirmation by the Senate when it meets gain in January, 1932. In announcing the appointments, Governor Roosevelt stated that he expected members of the Authority to effect their preliminary organization within the next few weeks.

Forty-Six Welded Boilers

UNDER THE TITLE "U. S. Navy Steps Out With Welded Boilers," an article on page 734 of this number lists 38 such boilers ordered by the Navy. Since the article went to press it has been learned that 8 more welded boilers have been ordered for another scout cruiser, bringing the total number up to 46.

STATOR FRAME OF GIANT OVERHUNG UNIT

Part of one of the world's largest overhung hydro-electric generators capable of developing 56,250 Kva., under construction at the Schenectady works of the General Electric Company for the Northwestern Electric Company, Washington. The stator frame with a section of the enclosing features and partial mounting of the exciter shown here, weighs approximately 285,000 lb. It is 10 ft. high and nearly 38 ft. in. diameter. The installation which will eventually include four of these units, is known as the Ariel project

▼ ▼ ▼

Bill Would Give Excess Utility Profits to Pa.

A BILL providing that all net earnings of public utility companies in excess of 8 per cent on the property valuation shall be turned over to the state treasury has been passed by the Pennsylvania House of Representatives. Earnings in excess of 7 per cent but not exceeding 8 per cent would be divided equally between the state and the utility company, according to the bill. The measure would establish the prudent investment method of valuation for new companies and those seeking a material increase in charter rights or to merge their properties. Certificates of public convenience would be limited to a term of 50 years, with preference in granting them given to municipal undertakings or power districts that can show they will furnish better or lower-cost service.

The bill is one of three measures advocated by Governor Pinchot and passed by the House for increasing the effectiveness of utility regulation in the state. The other two measures provide for the abolishment of the present Public Service Commission and the creation in its stead of a Fair Rate Board composed of seven members appointed by the Governor with the consent of two-thirds of all the members of the Senate. The board would have jurisdiction over all rate changes and the issuance of securities by public utilities, together with jurisdiction over holders of 1 per cent or more of voting capital stock and affiliated interests holding 10 per cent or more of stock. Management, engineering and other contracts would be submitted to the board for approval, and it would have charge of the inspection of all meters with power to impose penalties upon the utilities if the meters proved incorrect.

Propose $20,000,000 Steam Plant for Los Angeles

THE DEPARTMENT of water and power of the city of Los Angeles, Calif., has received from Welburn Mayock, Los Angeles attorney, an offer of the Densel Company of Utah to build a steam-electric generating plant in Los Angeles to provide the city with electric power for a twenty-year period and at the end of that time transfer ownership of the plant to the city. Under the offer, energy would be sold to the city at 5.7 mills per kilowatt-hour, with the guarantee that the city would use 2,000,000 kw-hr. per day for the twenty-year period.

The Densel Company, according to its attorney, owns and operates coal mines in Utah. From its coal, the company proposes to make coke to be used in the proposed plant, and also would manufacture dry ice as a by-product of the steam plant. The cost of the plant, according to the offer made the city, would be $20,000,000. The department of water and power referred the proposal to the city's legal and engineering departments for study.

Power Tax Bills Pass S. C. and Vt. Legislatures

A BILL levying a tax of one-half a mill per kilowatt-hour on all electric power generated or sold in South Carolina was passed on May 4 by the House and Senate. The measure has been sent to the Governor for approval. Passage of the bill follows an unsuccessful attempt in March to put through the legislature a similar measure, which provided for a tax of one-half of a mill per kilowatt-hour on all hydro-electric energy generated in the state.

In Vermont a revenue measure providing for a tax of one-half a mill per kilowatt-hour on all electrical energy generated within the state has been passed by the House and awaits the approval of the Senate.

A.S.M.E. Boiler Committee Changes Welding Codes

THE PROPOSED CODES for the fusion welding of unfired pressure vessels and the drums or shells of power boilers were considered at a recent meeting of the Boiler Code Committee of the American Society of Mechanical Engineers. Important changes were made in view of the criticisms and suggestions that had been received, including those from the American Welding Society and the Compressed Gas Manufacturers Association.

The proposed codes with the revisions which were agreed upon will be published in the June issue of *Mechanical Engineering*. It is contemplated that final action on them will be taken at the June meeting of the Boiler Code Committee. It is important, therefore, that all discussions be received before June 15, the committee states.

Preprints of the proposed codes will be available about May 15, it is said, and may be secured by communicating with the Secretary of the A.S.M.E. Boiler Code Committee, 29 West 39th St., New York City.

Plan Mechanical Handling Exhibit in New York City

PLANS are now being made to hold the first National Exposition of Mechanical Handling in Grand Central Palace, New York City, on Nov. 30 to Dec. 5. This is the initial attempt at staging an exhibition devoted exclusively to this subject, and it is designed to include all materials handling devices used in construction, manufacturing, and power

plants. Following are some of the equipment that will be on display: all types of conveyors, ash hoists, fuel and refuse handling machines, cranes, derricks, weighing machinery, overhead tramways, loading and unloading devices, engines, pumps, lubricating systems, and lubricants.

During the course of the exposition, the American Society of Mechanical Engineers will hold its annual meeting in New York City, and it is expected that other organizations will be in session in the city at the same time.

Start Large Gas Lines in Montana and New York

CONSTRUCTION WORK was started recently on the $15,000,000 pipeline and distribution system to transport natural gas 250 miles from the fields in northern Montana to cities and industries in the southwestern section of the state. The project is said to be the largest construction work begun in the state since the pioneering of the transcontinental railroads. The Montana Power Company already has franchises to serve many of the cities, including Butte and Anaconda whose industries will use more than 10,000,000,000 cu.ft. of gas annually, it is estimated.

In New York State, the Lycoming Gas Company, a subsidiary of the Standard Oil Company of New Jersey, completed on May 2 its survey for a 20-in., 110-mile natural gas pipeline from a point near Tioga, Pa., where it has producing properties, to Syracuse, N. Y. Construction under the direction of the company's engineers will begin in 30 days, with completion expected in six months. The cost of the project is estimated at $2,500,000. The combined output of the producing wells at Tioga is 40,000,000 cu.ft. of gas daily.

History of Science Congress In London, June 29-July 3

ANNOUNCEMENT is made that the Second International Congress of the History of Science and Technology will be held in London, England, from June 29 to July 3, with headquarters at the Science Museum, South Keinsington. The program for the congress will include papers of historic and scientific interest, social gatherings and visits to historical institutions and places.

The congress originated with the Comité International d'Histoire des Sciences which was founded at Oslo, Norway, on Aug. 17, 1928. This body meets annually in Paris and organizes every three years a congress.

For the coming congress the Comité has enlisted the co-operation of its parent body, the Comité International des Sciences Historiques together with that of two other international societies the History of Science Society, and the Newcomen Society.

Sales of Boilers, Stokers and Pulverizers Reported for First Three Months of 1931

NEW ORDERS for 1,744 boilers of 1,863,850 sq.ft. were placed in the first three months of this year, according to reports submitted to the United States Bureau of the Census by 73 manufacturers comprising most of the leading establishments in the industry. Sales for the corresponding period of 1930 amounted to 2,792 boilers of 3,284,364 sq.ft. During the first quarter of 1931, 598 boilers were sold in January, 516 in February and 630 in March. The following table gives the number, kind and square footage of all boilers sold in the first three months of 1931 and 1930:

Kind	1930 No.	1930 Sq.Ft.	1931 No.	1931 Sq.Ft.
Stationary:				
Water tube	280	1,620,955	169	793,088
Horizontal return tubular	210	293,495	112	134,712
Vertical fire tube	325	105,750	172	46,535
Locomotive (not railway)	52	38,236	15	10,343
Steel heating	1,479	653,916	998	489,594
Oil country	219	245,794	135	148,700
Self contained portable	128	87,281	66	39,259
Miscellaneous	37	15,609	15	11,588
Total	2,730	3,061,036	1,682	1,673,819
Marine:				
Water tube	33	197,922	31	170,393
Pipe	2	2,236	2	2,998
Scotch	22	19,873	19	6,970
Miscellaneous	5	3,297	10	9,670
Total	62	223,328	62	190,031

Sales of mechanical stokers for the first quarter of 1931, as reported to the Bureau of the Census by the eleven leading manufacturers, totaled 215 stokers of 58,144 hp., as compared with 215 stokers of 68,249 hp. for the corresponding period of last year. Of the stokers sold in the 1931 period, 111 were for installation under water-tube boilers and 104 for fire-tube boilers.

Orders for pulverizers for boiler installations in the first three months of 1931, as reported to the Bureau of the Census, aggregated 39 pulverizers having a total capacity of 341,500 lb. of coal per hour contract. Of these 5 with a combined capacity of 160,000 lb. were for use in the storage system to fire water-tube boilers; 23 with a total capacity of 170,500 lb. were for use in the unit system to fire water-tube boilers; and 11 with a combined capacity of 11,000 lb. were for use in the unit system under fire-tube boilers. Since the Census Bureau did not start reporting sales of pulverizers until April, 1930, the corresponding figures for last year are not available.

Exports of power generating equipment for the first quarter of 1931, as reported to the Department of Commerce, amounted to the following totals: steam engines, $11,013; steam turbines, $72,990; boilers, $110,208; steam-plant accessories, $462,324; diesel engines, $341,115; water wheels and water turbines, $432,719. Figures for the corresponding period of 1930 are: steam engines, $41,833; steam turbines, $92,911; boilers, $426,315; steam-plant accessories, $704,256; diesel engines, $1,055,917; water wheels and water turbines, $102,785.

V. D. I. 75 YEARS OLD

This memorial statue, dedicated to the founders of the Verein Deutscher Ingenieure, will be unveiled on May 12 at Alexisbad, Germany, where the society was formed 75 years ago. Further celebration of the 75th anniversary will take place at the annual meeting of the society in Cologne, June 27 to 29

Insull Concern Buys Eastern N. J. Power Co.

NATIONAL PUBLIC SERVICE CORPORATION, a part of the Middle West Utilities System, has purchased all of the common stock of the Eastern New Jersey Power Company, from the Utilities Power & Light Corporation.

The purchase makes National Public

Service second only to the Public Service Corporation of New Jersey in the volume of its public utility holdings in the State of New Jersey. The company already controls the Jersey Central Power & Light Company, furnishing gas service to Asbury Park and surrounding territory, and electric service in Morristown, Red Bank, Long Branch, and 152 other communities.

As a result of the purchase National Public Service increases its annual consolidated gross revenues to approximately $36,000,000, and total assets to $264,000,000.

A.S.A. Approves Personnel Of Welding Committee

F. M. FARMER, representing the American Institute of Electrical Engineers and the American Welding Society, has been appointed chairman of the A.S.A. sectional committee on electric welding apparatus, the personnel of which has just been approved by the American Standards Association. In accordance with the scope of the committee's work, which was also approved by the association, the committee will formulate standards for electric welding apparatus, including definitions of terms, classification, rating, heating, efficiency, testing methods, dielectric test, values of current and voltage and nameplate data.

Membership of the committee is made up of the following representatives of engineering and trade associations: J. L. Wilson, American Bureau of Shipping; F. McVittie, A.E.R.A.; A. M. Candy and J. W. Owens, A.I.E.E.; F. H. Frankland, A.I.S.C.; Lem Adams, A.R.A.; N. M. Loney, A.S.M.E.; F. M. Farmer and F. P. McKibben, A.W.S.; A. B. Morgan, N.E.L.A.; James Burke and L. D. Meeker, N.E.M.A.; Alexander Churchward, S.A.E.; Lt.-Com. N. L. Rawlings, U.S.N.; H. A. Woofter and R. S. Donald, members-at-large.

Electrical Equipment Ordered for Hoover Dam

ANOTHER STEP in the construction of the Boulder Canyon project has been taken by the Six Companies Inc., of San Francisco, with the award to the Westinghouse Electric & Manufacturing Company of the contract for the electrical equipment for the erection of Hoover Dam. The contract covers motors and control for driving all electric shovels, hoist pumps, conveyors and compressors, also electric locomotives, switching equipment, circuit breakers, switchboards and transformers, lightning arresters, and meters. Manufacture and delivery of this machinery will start at once, it is stated, and a large part of the equipment will be built in the Westinghouse works at Oakland, Calif.

COMING CONVENTIONS

American Society of Mechanical Engineers. Lubrication meeting at Pennsylvania State College, May 22. Meeting at Hartford, Conn., June 1-3. National Oil and Gas Power Meeting at the University of Wisconsin, Madison, Wis., June 23-26. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Boiler Manufacturers Association. Annual convention at Skytop Lodge, Skytop, Pa. May 25-27. Secretary, A. C. Baker, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Electrical Engineer. Annual summer convention in Asheville, N. C., June 22-26. District meeting at Lake Tahoe, Calif., Aug. 25-28. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Heating and Ventilating Engineers. Semi-annual meeting at the New Ocean House, Swampscott, Mass., June 22-26. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

American Society for Testing Materials. Annual meeting at the Stevens Hotel, Chicago, Ill., June 22-26. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Refractories Institute. Annual spring meeting at The Greenbrier, White Sulphur Springs, W. Va., May 25-26. Secretary, Dorothy A. Texter, Oliver Building, Pittsburgh, Pa.

Association of Iron and Steel Electrical Engineers. Annual meeting and exposition at the Cleveland Public Auditorium, Cleveland, Ohio, June 15-19. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

1931 Midwest Bituminous Coal Conference. To be held at the University of Illinois, Urbana, Ill., May 21-22. Chairman of Program Committee, B. R. Gebhart, Illinois Coal Bureau, 307 North Michigan Ave., Chicago, Ill.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago.

National Association of Purchasing Agents. Annual convention and exhibit at the Royal York Hotel, Toronto, Canada, June 8-11. Secretary, G. A. Renard, 11 Park Place, New York City.

National District Heating Association. Annual convention at the Hotel Statler, Boston, Mass., June 2-5. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 8-12. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Universal Craftsmen Council of Engineers. Annual convention at the Sherman Hotel, Chicago, Ill., Aug. 4-8. Secretary of Convention Committee, James J. Blaine, 7342 Harvard Ave., Chicago, Ill.

Personals

FRANK R. PHILLIPS, senior vice-president of the Philadelphia Company, was recently elected president of the company to succeed JOHN J. O'BRIEN, who is now president of the parent organization, Standard Gas & Electric Company. A nationally known figure in the public utility industry, Mr. Phillips has been connected with utilities in Pittsburgh for the past 21 years.

GEORGE A. ORROK, DAVID MYERS and W. A. SHOUDY, consulting engineers announce the removal of their offices to 21 East 40th St., New York City.

PAUL L. HOLLAND has been appointed chief engineer of the Maryland Public Service Commission. He was formerly a member of the consulting engineering firm of Mees & Mees, Charlotte, N. C., and previous to that was general superintendent of the Georgia-Alabama Power Company at Albany, Ga., a member of the engineering department of the Carolina Light & Power Company and chief engineer of the Blue Ridge Power Company, Spartanburg, S. C.

ARTHUR E. CHRISTEN, consulting engineer, has opened offices in Toledo, Ohio, for the practice of mechanical and electrical engineering work.

GEORGE H. CLIFFORD, president, and C. F. W. WETTERER, vice-president of the Stone & Webster Service Corporation have transferred their offices from Boston to the new Stone & Webster building in New York City. DONALD C. BARNES, division manager of the corporation, will also have his office in New York and has been made vice-president of the Engineers Public Service Company. DAVIS W. DE BARD will handle the sales direction of Engineers Public Service at the New York office.

H. L. FARRAR, for the past four years general superintendent of gas operation for the Western United Gas & Electric Company, Aurora, Ill., has been appointed to the staff of Standard Management & Operating Corporation, San Francisco, Calif., in charge of operations for all gas and electric companies subsidiary to Pacific Public Service and operated by the Standard corporation. These subsidiaries include Coast Counties Gas & Electric Company, Natural Gas Corporation of California, Natural Gas Corporation of Washington and affiliated organizations.

THOMAS E. PENARD has recently been appointed assistant superintendent of the station engineering department of the Edison Electric Illuminating Company of Boston. Mr. Penard was formerly head of the electrical division.

DR. OTTO KIRSCHMER, who until recently was director of the Research Institute for Water Works and Water Power of München and Walchensee, Germany, has been made professor of hydraulics of the University of Dresden.

Business Notes

STONE & WEBSTER, INC., New York City, recently moved into its new building at 90 Broad St. Besides the parent company, the 25-story structure will house the New York offices of STONE & WEBSTER and BLODGETT, INC., STONE & WEBSTER ENGINEERING CORPORATION, ENGINEERS PUBLIC SERVICE COMPANY and STONE & WEBSTER SERVICE CORPORATION.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y., reports that orders received for the first quarter of 1931 amounted to $60,366,297, compared with $90,397,731 for the corresponding period of last year. Profit available for dividends on common stock for the 1931 period was $10,844,334, compared with $14,398,790 for the first quarter of 1930.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., reports that orders received for the first quarter of 1931 amounted to $30,100,410, compared with $47,150,196 for the corresponding period of 1930. A deficit of $2,885,945 was incurred during the first three month of this year, compared with a profit available for dividends of $4,546,618 for the quarter of last year.

UNITED STATES STEEL CORPORATION, New York City, announces that it has signed an agreement with the Krupp steel interests of Germany under which United States Steel's subsidiaries will be licensed under Krupp patents to manufacture certain stainless, corrosion-resistant and other alloy steels for American consumption.

STACEY ENGINEERING COMPANY, Connersville, Ind., has merged with the INTERNATIONAL DERRICK & EQUIPMENT COMPANY of Columbus, Ohio, to form a new company known as the STACEY INTERNATIONAL CORPORATION, with headquarters in Columbus. The new concern will continue to operate the blower division in Connersville under the name of the Roots-Connersville-Wilbraham Division, and will also operate the Hayton Pump & Blower Division.

CUTLER-HAMMER, INC., Milwaukee, Wis., announces the election of Frank R. Bacon, former chairman of the board, as president to fill the vacancy caused by the death of Beverly L. Worden. Other officers elected are: Vice-presidents, F. L. Pierce and J. C. Wilson; treasurer, H. F. Vogt; and secretary, W. C. Stevens. The office of chairman of the board has been abolished.

SULLIVAN MACHINERY COMPANY, Chicago, Ill., announces the appointment of Edwin T. Hall as manager of its Boston office to succeed George H. Richey, who died on April 1 as the result of an accident. For the past fifteen years Mr. Hall had been associated with Mr. Richey in the New England sales district.

WITH THE SOCIETY SECTIONS

A.S.M.E., Metropolitan Section. Power division meeting in Room 501, Engineering Societies Building on May 13 at 8 p.m. Subject: "Performance of a Pulverized Coal Fired Boiler, Using the Unit System and Tangential Firing," by J. J. Grob and Gilbert Gershberg, United Electric Light & Power Company.

A.S.C.E., Boston Section. Meeting at Tremont Temple on May 20 at 7 p.m. Subject: "Fifteen Mile Falls Lower Development on the Connecticut River," by C. R. Bliss, New England Power Engineering & Service Corporation.

A.S.R.E., Boston Section. Dinner meeting at the Chamber of Commerce on May 21 at 6:15 p.m. Subject: "A Symposium on Insulating Materials," by technical representatives of companies manufacturing low-temperature insulants.

N.A.P.E., New England Association. Annual convention at Worcester, Mass., June 18-20. Secretary, W. B. Powers, 498 Green St., Cambridge, Mass.

Plant Engineers' Club. Dinner meeting at the University Club, Boston, Mass., on May 21 at 6:30 p.m. Subject: "Corrosion-Resisting Alloys," Prof. Albert Sauveur, Harvard University.

Trade Catalogs

REFRACTORIES—Bulletin 144 of the Denver Fire Clay Company, Denver, Colo., illustrates and describes firebrick bonding mortars and coatings for high-temperature service. Directions for laying fire brick are included in the bulletin.

CARBON BRUSHES—The National Carbon Company, Cleveland, Ohio, has recently issued a carbon-brush manual designed to simplify the selection and specification of carbon and metal-graphite brushes. Essential details for a complete brush specification are listed and discussed, and a cross index of grades and their applications is included.

ROLLER CHAINS—A small booklet describing and illustrating roller-chain usage has just been issued by the Diamond Chain & Manufacturing Company, Indianapolis, Ind. The booklet takes up eight points of roller-chain application that contribute to machine improvement through simplified design.

SPEED REDUCERS—The D. O. James Manufacturing Company, 1114 West Monroe St., Chicago, Ill., has just published a new catalog, No. 136, covering a complete line of continuous-tooth herringbone speed reducers and gears. Dimensions, ratings and prices are given in the catalog, together with illustrations of many speed reducer installations.

HEATERS—Two new bulletins on gas-fired warm-air heating appliances for buildings of every type have just been issued by the Reznor Manufacturing Company, Mercer, Pa. One describes and illustrates Type V gas-fired warm-air forced-circulation heater, and the other, Type 1-UR gas-fired warm-air heating and ventilating unit.

CONVEYORS—The Fairfield Engineering Company, Marion, Ohio, has recently issued an illustrated bulletin, No. 40-1, which gives detailed information on portable belt conveyors and their applications.

REFRIGERATION—An illustrated description of the Carrier B-K cold diffuser for cooling foods and other products is contained in Bulletin No. 10 recently issued by the Brunswick-Kroeschell Company, New Brunswick, N. J.

Fuel Prices

FUEL OIL

Boston—May 4, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.92c. per gal.; 28@32 deg., 4.9c. per gal.

New York—May 7, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

Philadelphia—April 26, No. 3, industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl.

Pittsburgh—April 29, f.o.b. local refinery, fuel oil, 30@34 deg., 2.875c.@3c. per gal.; 36@40 deg., 2.875c.@3c. per gal.

Cincinnati — May 5, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—April 26, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 46.25c. per bbl.; 22@24 deg., 51.25c. per bbl.; 24@26 deg., 52.5c. per bbl.; 26@28 deg., 62.5c. per bbl.; 28@30 deg., 76.25c. per bbl.

St. Louis — May 5, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.19 per bbl., or 42 gal.; 26@28 deg., $1.325 per bbl.; 28@30 deg., $1.42 per bbl.; 30@32 deg., $1.52 per bbl.; 32@36 deg., gas oil, 2.901c. per gal.; 38@40 deg., distillate, 3.776c. per gal.

Dallas—May 2, f.o.b. local refinery 24@26 deg., $1.05 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.70 @ $1.90
Pool 10, h. gr. low-vol.	New York	1.60 @ 1.70
Pool 11, low-vol.	New York	1.40 @ 1.50
Smokeless, mine-run	Chicago	1.50 @ 1.75
Smokeless, slack	Chicago	1.25 @ 1.35
Harlan, Ky., slack	Chicago	1.10 @ 1.20
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.50 @ 1.75
Ind. 5th Vein, m.-r.	Chicago	1.20 @ 1.75
Standard Ill., mine-run	St. Louis	1.25 @ 1.40
W. Ky., mine-run	Louisville	.85 @ 1.25
W. Ky., slack	Louisville	.65 @ .85
Pittsburgh, mine-run	Pittsburgh	1.35 @ 1.45
Smokeless, mine-run	Cincinnati	1.65 @ 1.75
Smokeless, slack	Cincinnati	1.10 @ 1.25
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, nut-slack	Cincinnati	.85 @ 1.10
Anthracite (Net Tons)	**At Mine, for Shipment to**	**Price per Ton**
Buckwheat	New York	$3.25 @ $4.00
Barley	New York	1.00 @ 1.40

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Orange—Orange Mutual Citrus Association, J. T. Snowden, Pres., awarded contract for a 2 story, 85 x 135 ft. pre-cooling plant to Adolf G. Schmid, 200 Builders Exchange Bldg., Santa Ana. Estimated cost $80,000.

Conn., Bristol—Connecticut Light & Power Co., W. W. Foreman, Leavenworth St., Waterbury, will build a steam regenerating plant on Riverside Ave. here. Estimated cost $40,000. Work will be done by day labor.

D. C., Washington—Treasury Dept., Office of the Supervising Architect, awarded contract for remodeling power house, also extensions to U. C. Spratt, Fredericksburg, Va. $49,900.

Kan., Colby—Syms-Shafer Grocery Co., will soon receive bids for the construction of a 2 story, 60 x 265 ft. cold storage plant. Estimated cost $50,000. B. H. Byrnes, 312 National Bank of America Bldg., Salina, is architect.

Kan., Dodge City—Kansas Power Co., Topeka, awarded contract for smokestack, 104 ft. high and 10 ft. in diameter for power plant to Alphonse Custodis Chimney Construction Co., 140 South Dearborn St., Chicago, Ill. Closing bids for two 600 hp. boilers, 6000 kw. turbine, air heaters, etc.

Mass., Boston—Adams House Realty Corp., 857 Commonwealth Ave., awarded contract for the construction of a theatre on Washington St., to G. B. H. Macomber Co., 38 Chauncy St. Estimated cost $2,500,000.

Mass., Boylston—Worcester County, W. Goodale, chn., Court House, will receive bids until May 15 for the construction of a hospital, sanitorium, nurses home, power house and service building. Frost, Chamberlain & Edwards, Boylston, are architects.

Mass., Chelsea—Bureau of Yards & Docks, Navy Dept., Washington, D. C., received lowest bid for the construction of a refrigerating and ice making plant at Naval Hospital here, from Vilter Mfg. Co., 935 Clinton St., Milwaukee, Wis.

Mass., Everett—(br. Boston)—New England Fuel & Transportation Co., 250 Stuart St., Boston, awarded contract for three plant units including conveyor belt house and coal bin, etc. at Rover St. Ext. to Koppers Construction Co., Koppers Bldg., Pittsburgh, Pa.

Mass., Holyoke—Electro Ice Co., Commercial St., awarded contract for the construction of a 1 story, 65 x 100 ft. ice manufacturing plant, to P. J. Kennedy & Co. Inc., 326 Appleton St. Estimated cost $40,000.

Mass., Reading—Dept. of Public Works, will soon award contract for the construction of a pumping station near Grove St. Estimated cost $50,000. Weston & Sampson, 14 Beacon St., Boston, are engineers.

Mass., Vineyard Haven—Cape & Vineyard Electric Co., is having preliminary plans prepared for addition to power plant on Beach St. Estimated cost $40,000. Private plans.

Minn., Duluth—Bd. of Education, F. D. Knight, Pres., City Hall, will soon award contract for heating plant for central high school. J. Wilson, City Hall, is engineer.

Miss., Starkville—City is having preliminary surveys made for the construction of a light and power plant. Estimated cost $50,000. Swanson & McGraw, Balter Bldg., New Orleans, La., are engineers.

N. J., Holmdel—Dept. of Institutions & Agencies, W. Ellis, Comr., State Office Bldg., Trenton, awarded contract for the construction of a reception and treatment hospital at New Jersey State Hospital here, to E. M. Waldron Inc., 40 Park Pl. Estimated cost $1,000,000. Steam heating and ventilation systems, boilers, elevator, etc. will be installed.

N. Y., Brooklyn—Brooklyn & Queens Transportation Co., 385 Flatbush Ave. Ext., will receive bids after May 18 for the construction of a sub-station at Ocean Ave. and Ave. H. Estimated cost $40,000. Private plans.

N. Y., Brooklyn—Dept. of Mental Hygiene, State Office Bldg., Albany, will soon award contract for refrigeration work, laboratory building and electric service connections to superintendents residence, Brooklyn State Hospital, Creedmoor Division here.

N. Y., New York—Bd. of Transportation, awarded contract for the construction of Jay and Smith St. sub-stations, part of Rapid Transit Railroad to Reiss Construction Co. 186 Remsen St., Brooklyn. $128,742.

N. Y., New York—Henry Mandel Corp., 10 East 40th St., plans the construction of a 19 story apartment building at 7th Ave. and 19th to 20th Sts. Estimated cost $4,000,000. Farrar & Watmough, 10 East 40th St., are architects. Work will be done by separate contracts. Bids will be taken June 1 on excavation, foundation, steel, etc.

N. Y., New York—One Hundred Twenty Park Ave. Corp., c/o W. Ziegler, Pershing Sq. Bldg., plans the construction of a 60 story office building at Park Ave. and 42nd St. Estimated cost $20,000,000.

N. Y., New York—Shire Realty Co., 26 Court St., Brooklyn, will soon award contract for the construction of a boiler plant and storage building, etc., at 1220 Broadway here. Estimated cost $150,000. Levy & Berger, 375 Fulton St., Brooklyn, are architects.

N. Y., Suffolk County — Dept. of Mental Hygiene, State Office Bldg., Albany, will receive bids until May 20 for refrigeration equipment, cold storage plant, etc., at Pilgrim State Hospital here.

O., Norwood—Globe-Wernicke Co., Carthage Ave., plans the construction of a 2 story, power plant. Estimated cost $250,000. Kinney & Ehlers Inc., Dixie Terminal Bldg., Cincinnati, are engineers.

Okla., Pryor—Grand River Power Co., Tulsa, Okla., plans the construction of a hydro-electric plant on Grand River near here. Estimated cost $2,000,000. Private plans.

Pa., Aspinwall—Dept. of Public Works, E. G. Lang, Dir., Pittsburgh, will soon award contract for the construction of Brilliant pumping here. Estimated cost $176,500.

Pa., Conway—Pennsylvania R.R., W. D. Wiggins, Pennsylvania Station, Pittsburgh, plans a rail river terminal including coal handling equipment and crane on Ohio River to General Contracting Co., Columbia Bank Bldg., Pittsburgh. Estimated total cost $350,000. Contract awarded for dredging.

R. I., Howard—Dept. of Public Welfare, State House, Providence, is having plans prepared for the construction of a reformatory including ice plant here. Estimated cost $500,000. T. H. Murphy, Jr., Howard, is architect.

S. D., Huron—City had tentative plans made for the construction of a dam on James River for storing water and possibly power development. Estimated cost $300,000. Engineer not selected.

Tex., Hillsboro—W. S. Grimes and W. D. Little, Hillsboro and Fort Worth, are having plans prepared for the construction of a 60 ton ice plant on Elm St. here. Estimated cost $50,000. Private plans.

Tex., San Antonio—Longhorn Athletic Club, E. H. Kifer, Pres., c/o A. B. and R. M. Ayres, Smith-Young Tower, Archts., plans the construction of a 14 story athletic club, including swimming pool, etc., on Villita St. Estimated cost $1,000,000. W. Simpson, Milam Bldg., is engineer.

Tex., Thorndale—City will soon award contract for the construction of a complete waterworks system including pumps and motors, etc. J. Rady, 425 Provident Bldg., Waco, is engineer.

Tex., Vega—City voted $25,000 bonds for waterworks system including reservoir, pumping equipment, mains, etc.

Vt., Bennington—State of Vermont, State House, Montpelier, is having preliminary plans prepared for the construction of a heating plant at Soldiers Home here. Estimated cost $40,000. F. L. Austin, 240 College St., Burlington, is architect and engineer.

Wash., Cle Elum—Dept. of Interior, Washington, D. C., will receive bids about May 15 and open same about June 15 for the construction of a dam 125 ft. high on Cle Elum River. Project includes replacement of pumping plant and pipe line; canal 1,000 second ft. capacity, 24 mi. long, to develop 40 ft. of head water and produce 3,200 hp. of electrical energy. $3,500,000.

Ont., Bolton—Village plans the construction of a waterworks system including pump house, pumps, etc. Estimated cost $25,000. Engineer not selected.

Ont., Picton—Prince Edward County Co-Operative Ltd., and Provincial and Dominion Governments, plan the construction of a cold storage plant for fruits and vegetables including artificial refrigeration, etc. Estimated cost $100,000. Margison & Babcock, McLean Bldg., Canadian Pacific Bldg., Toronto, are engineers.

Ont., Saulte Ste Marie — Algoma District Power Co., 527 Queen St. E.: plans the construction of a dam on Montreal River, also installation of hydro-electric power machinery, power house, electrical equipment. Estimated cost $1,000,000. Lang & Ross, 650 Queen St. E., are engineers.

Equipment Wanted

Boiler—St. Louis, Mo.—Advance Laundry Machinery Co., 5483 Union Blvd., plans to purchase a 25 or 30 hp. boiler.

Filter Equipment, Pumps, etc.—Joliette, Que.—E. E. H. Lippe, City Engr., will receive bids until May 15 for filter equipment, low pressure pumps, etc., for 3,000,000 gal. mechanical gravity filtration plant.

Generating Unit—Fredonia, Kan.—City, O. C. Wilson, Clk., will receive bids until May 18 for furnishing and erecting a 600 kw. oil engine generating unit and auxiliaries.

Generators, Water Wheels, Etc.—Seattle, Wash.—Bd. of Public Works, G. W. Roberge, Secy., will receive bids until May 15 for assembling and installing hydro-electric machinery and equipment including two 66,700 kva. main generators, two 1,500 kva. house generators, four water wheels, etc. for Diablo power plant. Estimated cost $200,000 to $300,000.

Pump—Grand Forks, N. D.—City plans to purchase a sludge pump in connection with waterworks.

Pump—Beaumont, Tex.—City, c/o E. A. Fletcher, plans to purchase a 12,000 g.p.m. centrifugal pump for Weiss-Bluff pumping station.

Pump and Motor—Sanger, Calif.—City, F. Niles, Clk., will receive bids until May 19 for a 700 g.p.m. deep well turbine pump direct connected to vertical electric motor for waterworks.

Pumps—Exeter, Calif.—City, T. E. Awbrey, Clk., will receive bids until May 18 for furnishing and installing one deep well turbine pump, one horizontal centrifugal booster, for municipal water system.

Water Heaters, Exchangers, Separators, Pumps, etc.—Detroit, Mich. — Bd. of Water Commissioners, 735 Randolph St., will receive bids until May 19 for two low and two high pressure extraction type feed water heaters, two heat exchangers, two separators, four hot well pumps, two motor driven boiler feed pumps, one turbine driven feed pump, two hot drip pumps, etc., for power house.

Industrial Projects

Mass., Peabody—Carr Leather Co., 111 Foster St., awarded contract for the construction of a 5 story, 45 x 100 ft. leather factory to E. H. Porter Construction Co., 15 Wallis St. Estimated cost to exceed $40,000.

N. J., East Rutherford — East Rutherford Syringe Co., 75 Mozart St., is having revised preliminary plans prepared for the construction of a 2 story factory. Estimated cost $40,000. J. T. Camlet, 26 Piaget Ave., Clifton, is architect.

N. J., Newark—S. Shaw & Co., 24 Commerce St., Archts. and Engrs., will receive bids about June 1 for the construction of a 2 story factory for Unique Art Mfg. Co., 196 Waverly Ave. Estimated cost $100,000.

N. Y., Buffalo—DuPont Cellophane Co., 2 Park Ave., New York, and River Rd., Buffalo, plans addition to plant here. Estimated cost $2,000,000.

O., Cleveland—Lempco Products Inc., Dunham Rd., awarded contract for a 1 story, 70 x 160 ft. addition to factory to C. Hanacek, 4121 East 135th St. Estimated cost $100,000.

Tex., Beaumont — Coca Cola Bottling Co., plans the construction of a 2 story, 42 x 130 and 34 x 39 ft. bottling plant. Estimated cost $100,000. Pringle & Smith, 1012 Norris Bldg., Atlanta, Ga., are architects.

Ont., Oakville—Heater of Canada Co., c/o W. B. Riddell, Sun Life Bldg., Hamilton, Archts., awarded contract for the construction of a 1 story, 50 x 281 ft. factory to Stuart Bros. Ltd., 15 Hyde Park Ave., Hamilton. Estimated cost $50,000.

Ont., Oneida—Canadian Gypsum Co., D. R. Rodgers, Ch. Engr., Toronto, is having plans prepared for the construction of a plaster mill, wall board plant and warehouse. Estimated cost $100,000. Machinery and equipment will be required.

Ont., Thorold—Ontario Paper Co., Allanburg Rd., plans additions and alterations to plant. 2 story, 50 x 144 ft. Estimated cost total $500,000. J. Stadler, 1117 St. Catharine St. W., Montreal, Que., is engineer.

Ont., Toronto—Rogers-Majestic Corp., Fleet St., plans the construction of a 1 story, 44 x 56 ft. and radio plant including warehouse, etc. Estimated cost $100,000. Horwood & White, 229 Yonge St., are architects.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

PRICE declines of April included more of the electrical supplies than did those of the preceding month. The principal materials affected were BX cable, conduit, flexible cord, attachment plugs, rubber-covered copper wire, steam hose, rivets, babbitt metal, cement and linseed oil. Boiler flanges appear to be the lone exception to the downward trend this month in that lower discounts are being granted on this item. Market is steady in leather goods, packing, pipe and boiler covering, wiping materials and refractories.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket, net, per ft.	$0.51
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less	70%

Air—Best Grade, Net

¾-in., per ft.	3-ply $0.271	4 ply	$0.337

Steam—Discounts from List

First grade	59%	Second grade	60-5%	Third grade	60-10-10%

RUBBER BELTING—List price, 6-in., 6 ply, $1.83 per lin.ft. The following discounts from New York warehouse list apply to rubber transmission belting:

Best grade 60-10-10% Second grade 70-10%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses in quantities of about ½ doz. rolls:

Grade	Discount from list
Medium	30-10%
Heavy	30%

RAWHIDE LACING—Cut lacing, best quality, 30-10%; 2nd quality, 50%. Lace leather sides, best, 12-17 sq.ft., 55c. per sq.ft.; 2nd, 48c., net. Giant or Indian tanned cut lacing, 30-10%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		40 %
Asbestos, air cell, for low-pressure heating and return lines	4-ply	65 %
	3-ply	67½%
	2-ply	70 %

PORTLAND CEMENT—New York, $1.95@$2.00 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl. in cloth.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $2.90 per 100 lb. in lots of 1,000 to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	7.00@13.00	16.00	13.00
Colored	5.50@9.00	12.00	9.00

WIPING CLOTHS—Prices per pound in lots of about six bales (600 lb), for colored wipers, as follows:

Chicago	$0.09
New York	.10
Cleveland	.08

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Minneapolis	Chicago
Per pound	$0.096	$0.103	$0.102

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.25	$14.75
White	13.25	13.25

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, ⅞-in. diameter and smaller, list less 65% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, full kegs, per 100 lb.:

New York	$4.00
Chicago	4.00
Pittsburgh mill	2.75

Broken kegs, about 50c. higher.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome ore, ground, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome ore, ground, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Chrome ore, crude, 40@50%, Cr_2O_3	per net ton	18.00@22.50
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	32@35
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	32@35
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	32@35

BABBITT METAL—Delivered in case lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

Genuine, highest grade	44.00
Commercial genuine, intermediate grade	33.75
Anti-friction metal, general service	29.00
No. 4 babbitt, f. o. b.	10.00

COLD-FINISHED STEEL—Warehouse prices on shafting and screw stock, per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.40	$3.35
Flat or square	3.90	3.90	3.85

BOILER FITTINGS—Discounts from list at New York warehouse:

Copper ferrules	70%
Flanges	50%
Stay bolts	60%
Patch bolts	20%
Fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list, are for large mill lots at Pittsburgh mill:

BUTT WELD

Steel			Iron		
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	64%	52½%	1 and 1¼	31%	15%

LAP WELD

2	57%	45½%	2	23%	9%
2½ to 6	61%	49½%	2½ to 3½	28%	13%
7 and 8	58%	45½%	4 to 6	30%	17%
9 and 10	56%	43½%	7 and 8	29%	16%
11 and 12	55%	42½%	9 to 12	26%	11%

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1¼	62%	51½%	1 to 2	34%	18%
2 to 3	63%	52½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	55%	44½%	2	29%	13%
2½ to 4	59%	48½%	2½ to 4	34%	20%
4½ to 6	58%	47½%	4½ to 6	33%	19%
7 and 8	54%	41½%	7 and 8	31%	17%
9 and 10	47%	34½%	9 to 12	21%	8%
11 and 12	46%	33½%			

BOILER TUBES—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U.S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

Size, Inches*	B.W.G.	Toncan Seamless Iron	Knobbled Charcoal Iron	Seamless Steel	Lapwelded Steel
1	13	$34.00	.....	$18.00	.....
1¼	13	37.75	.....	20.25	.....
1½	13	38.00	$38.00	19.25	.....
1¾	13	30.00	30.00	22.00	.....
2	13	26.25	26.25	20.25	$19.00
2¼	13	34.50	34.50	23.00	25.00
2½	12	34.00	34.00	26.00	24.25
2¾	12	40.50	40.50	28.50	27.50
3	12	42.50	42.50	27.00	25.50
3¼	11	50.25	50.25	30.75	28.75
3½	11	54.50	54.50	33.25	31.50
4	10	67.00	67.00	40.00	38.00

These prices are based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller..$0.05 per cut
2¼ and 2½ in..... .06 per cut
3-in..... $0.09 per cut
3¼ to 4 in..... .10 per cut

*External diameter.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$20.00	$33.00	$66.00	$86.75
No. 12 solid....	38.02	50.52	76.00	104.00
No. 10 solid....	52.10	66.22	95.00	124.00
No. 8 stranded..	85.34	105.22	133.00	185.00
No. 6 stranded..	123.58	148.81	180.00	253.00

Coils to 1000 ft., +10%; less than coil lots, +20%.

CONDUIT—Rigid iron, price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra. Delivered from New York warehouse. Discount of 5 per cent for payment in 10 days; 30 days net.

Size, Inches	GALVANIZED Conduit	GALVANIZED Couplings	GALVANIZED Elbows	BLACK Conduit	BLACK Couplings	BLACK Elbows
¼	$59.07	$3.40	$8.14	$53.85	$3.09	$6.97
⅜	59.67	4.08	8.19	54.45	3.71	7.02
½	60.85	4.77	8.31	55.63	4.34	7.14
¾	77.55	6.84	10.94	70.47	6.23	9.41
1	111.17	8.93	16.34	100.71	8.13	14.06
1¼	150.41	12.59	22.45	136.26	11.54	19.69
1½	179.86	15.59	30.03	162.94	14.29	26.33
2	242.01	20.86	54.65	219.24	19.14	47.88
2½	382.64	29.80	90.41	346.64	27.33	79.33
3	500.40	44.66	233.65	453.32	40.97	204.12
3½	630.26	59.90	511.67	573.66	54.98	446.44
4	769.04	74.67	591.65	701.96	68.51	516.27
4½	895.85	111.37	891.90	817.71	102.13	777.77
5	1044.28	122.88	1240.38	953.21	112.72	1081.94
6	1354.64	177.68	1547.21	1236.49	162.91	1350.30

CONDUIT BODIES AND FITTINGS—Black or galvanized:

	Less Than $15 List	$15 List to $100	$100 List and Over
Standard package	15%	20%	28%
Less than standard package	10%	15%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$14.00
No. 16 cotton reinforced heavy		17.50
No. 18 cotton reinforced light		11.50
No. 16 cotton reinforced light		14.00
No. 18 cotton Canvasite cord		12.50
No. 16 cotton Canvasite cord		13.60
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$54.00	*59.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	82.00	*89.50

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.....	$0.50	$1.10	100	10
35 to 60-amp.....	1.00	1.25	100	10
65 to 100-amp.....	2.00	3.00	50	5
110 to 200-amp.....	4.00	5.00	25	5
225 to 400-amp.....	7.50	11.00	25	1
450 to 600-amp.....	11.00	16.00	10	1

REFILLS—

1 to 30-amp.....	$0.03 ea.	$0.05	100	100
35 to 60-amp.....	.05 ea.	.06	100	100
65 to 100-amp.....	.10 ea.	.10	50	50
110 to 200-amp.....	.15 ea.	.15	25	50
225 to 400-amp.....	.30 ea.	.30	25	25
450 to 600-amp.....	.60 ea.	.60	10	10

Discount Without Contract—Fuses:
Broken cartons..... Net list
Unbroken cartons..... 17%
Ten unbroken cartons..... 34%

Discount Without Contract—Renewals:
Broken cartons..... Net list
Unbroken cartons..... 17%
Ten unbroken cartons..... 34%

Discount With Contract—Fuses:
Broken cartons..... 5%
Unbroken cartons..... 20%
Ten unbroken cartons..... 36%

Discount With Contract—Renewals:
Broken cartons..... Net list
Ten unbroken cartons..... 36%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500), per 100	$2.50
0–30 ampere, less than standard package, per 100	2.75

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	.....	.....
60	A 21	.20	...	.....	.....
100	A 23	.35	...	.....	.....

Carton quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.05

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$4.50	$6.50	$7.60	$12.75
12	6.60	8.20	9.40	16.50
10	8.75	10.40	12.20	22.00
8	12.50	14.50	17.50	31.00
6	.....	.....	24.25	.....
4	.....	.....	34.50	.....
2	.....	.....	47.00	.....
1	.....	.....	67.00	.....
0	.....	.....	82.00	.....
00	.....	.....	95.00	.....
000	.....	.....	115.00	.....
0000	.....	.....	137.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	¼ In. or Pendant Cap Key	Keyless	Pull	½ In. Cap Key	Keyless	Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 28c. per lb.; in 100 lb. lots, 26c. per lb
Rubber tape, ¾ in., in less than 100 lb., 30c. per lb.; in 100 lb. lots, 27c. per lb
Wire solder, in less than 100 lb., 28c. per lb.; in 100 lb. lots, 26c. per lb.
Soldering paste, 2 oz. cans..... $1.10 doz

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.:

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:
Standard package..... 50%
Less than standard package..... 45%